The Welding Journal

JULY, 1939

American Welding Society

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GENERAL ELECTRIC

150-60

The American Welding Society Journal

W. SPRARAGEN, Editor

Published for the Advancement of the Science and Art of Welding

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ISSUED MONTHLY

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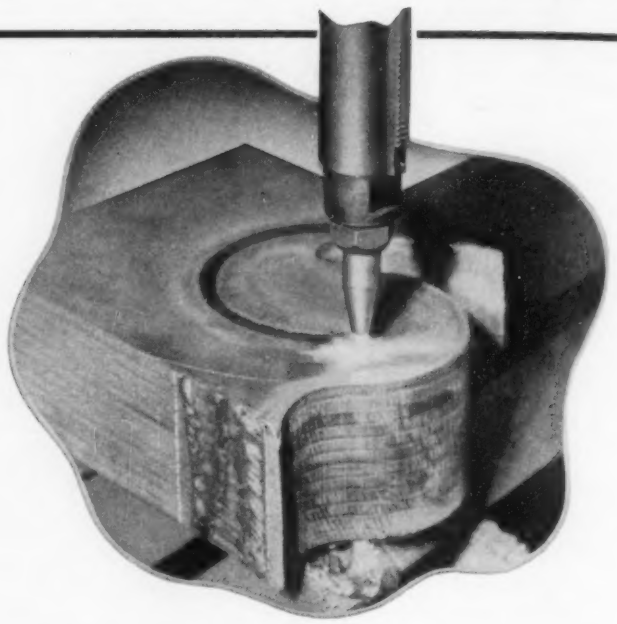

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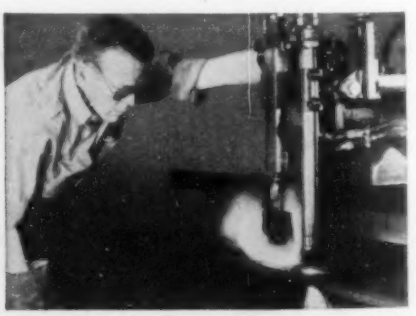

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Welding Journal

VOLUME 18, No. 7 JULY 1939

WELDING OF STEAM ELECTRIC Locomotive

By W. H. COCHRAN*

THE General Electric Company has recently completed the construction of, and placed in operation for the Union Pacific Railroad, a two-section steam electric locomotive of unusual design. Steam is generated by an oil-fired steam boiler at 1500 pounds pressure, and operates a 2500 kw. steam turbine-driven generator which in turn supplies power to the traction motors for driving the locomotive. Welding was extensively used in the building of this locomotive.

I—CAB FRAME

Each locomotive is 90 feet 4 inches long. The cab frame is suspended between the bolsters resting on the center plates of trucks. To carry the load of the apparatus placed in the cab, a truss type cab frame was designed, using low-alloy high-tensile steel. The analysis of the steel used for the cab frame is given in Table 1:

Table 1

Carbon	0.12 max.
Copper	1.50 max.
Manganese	1.00 max.
Nickel	1.00 max.
Molybdenum	0.20 max.

* Erie Works Laboratory, General Electric Company.

Extensive tests were made to find a suitable heavily-coated electrode for welding this steel. An electrode of carbon molybdenum analysis was finally selected. Table 2 gives the tests on plates welded with this electrode:

Table 2—Summary of Weld Tests on Low-Alloy Steel

Plate Thickness, Inches	Yield Point, Lb./Sq. In.	Tensile Strength, Lb./Sq. In.	Free Bend Per cent	
1	66,300	80,000	37	No anneal
1	59,700	68,750	55	Annealed 725° C.
1/2	65,000	79,400	37	No anneal
1/2	65,700	79,200	37	No anneal
1/4	67,900	88,000		
1/4	63,000	83,000		

Charpy impact tests on welds.
Plates 36.33 ft.-lb. per square inch.

These locomotive sections were the first units we had ever built from low-alloy steels, so it was necessary to train the welders to use the carbon moly electrode. Each welder was required to pass a qualification test in the flat, vertical and overhead position, as is our procedure on all locomotive work. Figures 2, 3 and 4 show details of the cab frame during construction.

It was necessary to fabricate some of the members of the cab frame from plate stock to obtain the required structural shapes. The side sills which formed the lower

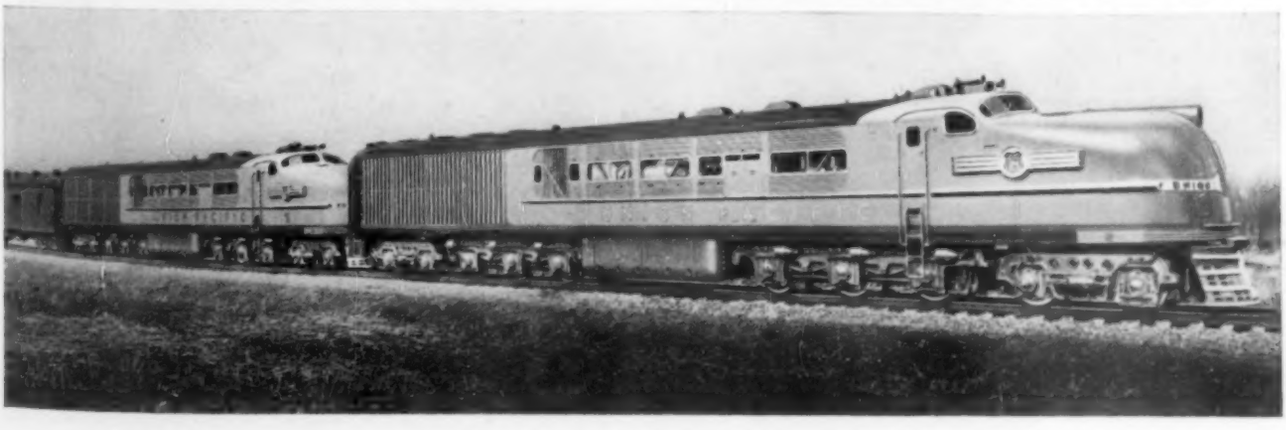
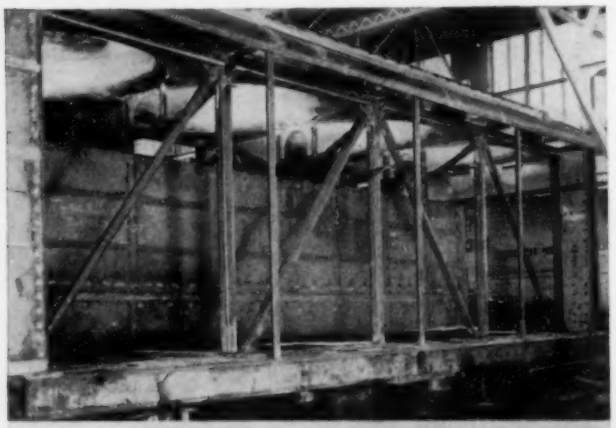


Fig. 1—View of Two-Section Steam-Electric Locomotive

Fig. 2—Cab Underframe and Truss Construction View of B Side at Rear End of Cab Showing Fuel Tank in Place



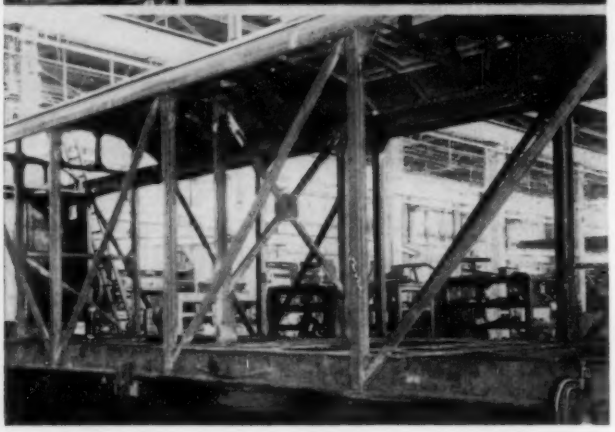


Fig. 3—View of Right Side, Middle Portion of Cab

chord of the truss were fabricated from rolled steel plates as shown in Fig. 5.

The bottom plate was clamped to a floor plate, and the welds made on both sides simultaneously. The welds were multi-pass welds, $^{5}/_{32}$-inch diameter electrode being used for the first passes, and $^{3}/_{16}$-inch diameter electrode used for the finishing passes. The "T" sections made as described were later spliced in the center of the truss, as shown in Fig. 3, to form a continuous side sill.

The top chord of the truss or the horizontal compression members were fabricated from two angles placed back to back with spacers and gusset plates welded between the angles. The gusset plates can be seen in Fig. 3. These gussets were used as the connection plates for the vertical members of the truss.

All vertical and diagonal members of the side trusses were made "U" sections formed from plate and welded to form a rectangular box section. Figure 6 shows a compression test made on one of these members. The two "U" sections were placed in fixture and welded in downhand position. Figure 7 shows details of welded section.

The fixture was designed so it could be rotated about the center. The welding on the seams was alternated from one side to the other to prevent distortion.

The bolsters were made from two plates, top and bottom, spaced by a plate set on edge and running the length and width of the top and bottom plates to form ribs of a box section. As much welding as was possible was done between the ribs and bottom plates before the top plate was in place. Holes were cut in the top and bottom plates so the welds could be made at the joints on the inside member. All welds were continuous. Fillet welds were used except on the two outside vertical plates which were prepared for 100 per cent weld through the vertical plates. The center plates were welded to the bottom plate of the bolsters. The bolsters were annealed at 725° C. after welding. Figures 8 and 9 show a half size bolster that was built up for load test and tested to destruction, to check the effect of twisting on the structure. It is interesting to note that none of the welds failed.

The bolsters with the center plates welded in place were placed in fixtures set at the right distance so as to space the center plates. The side sills were slipped in between the top and bottom plates of the bolsters by a fixture that gave the correct camber to the sills and spaced them from side to side. The side sills were spliced in this position. The splice can be seen in Fig. 2. The vertical and diagonal members had previously had a section cut out so as to fit over the side sills and over the gussets on the horizontal compression members. These members of the truss were joined to the horizontal members with $^{3}/_{8}$-inch fillet welds. The fits were good and all welding was done with parts in the position as shown in Figs. 2, 3 and 4. The cross members at the top which had previously been fabricated on the floor, were put in place and welded to the side members. The bottom of the side trusses were connected by the floor plate sections and cross ribs shown in Fig. 4. Holes were cut in the deck plates to facilitate welding some of the cross members and stiffeners. Fillet welds $^{5}/_{16}$-inch and $^{3}/_{8}$-inch were used for all corrections; $^{1}/_{2}$-inch fillet welds were used to connect the bolsters to the sills.

All connections and joints in the cab frame were arc welded. The rivets shown in the photographs were used to connect aluminum sections and bulkheads to the steel structure.

II—TANKS

The fuel oil and water tanks were fabricated from the same material as the cab frame. One of the fuel oil tanks is shown in place in the locomotive (Fig. 2). The

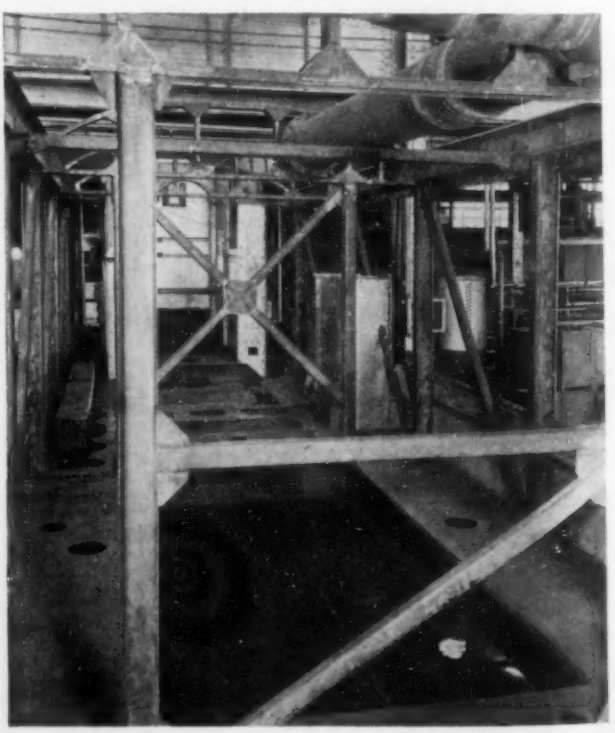


Fig. 4—Internal View Forward, Showing Space for Boiler and Propane Compartment

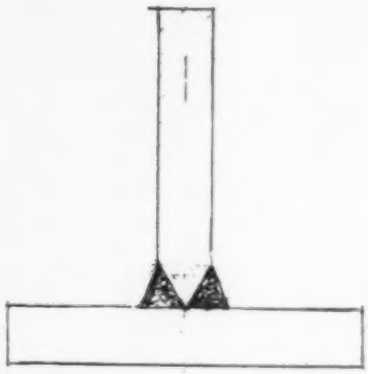


Fig. 5.—Section Through Side Sills

tanks were suitably braced with stiffeners and bulkheads. All butt seams were welded inside and out for added strength. Where it was not possible to weld the seams on the inside of the tank, a backing strip was used to insure 100 per cent fusion through the plate. To prevent corrosion of tanks, they were sprayed to a thickness of 0.015 inch with zinc.

III—MISCELLANEOUS PARTS OF CAB

Figure 10 shows louvres in place on the locomotive. These louvres cover the air-cooled steam condensers. The louvres were made from aluminum, formed to shape and welded along the edges. Figure, 11 shows section through louvre.

Some of the removable hatch covers were fabricated from aluminum sheets and angles and spot welded together. A spot thyratron controlled welder equipped with a high kva. capacity transformer was used for spot welding these parts fabricated from aluminum.

The electrodes were of the conventional water-cooled type with 7° angle face on the replaceable tips.

A rather novel resistance welding job was done on the nose of the locomotive. The cab sheets and operator compartment were made from aluminum sheets riveted with steel rivets to steel angles welded to the cab underframe. The front of the nose was made of alloy steel welded to the cab frame. It was necessary to place insulation inside the nose around the water tanks. A spot welding gun was used to weld nails to the inside of the steel nose and to the inside rivet heads that fastened the aluminum sheets to the frame. The insulation was pushed over these nails, a wire mesh placed over the insulation, and the nail ends were bent over washers to hold the wire mesh in place.

IV—BRAKING RESISTOR AND CONTROL, MOTORS AND GENERATORS

All silver contacts used on the control apparatus were projection welded to the controller fingers and relay parts.

Figure 12 shows a water-cooled braking resistor used to supply a load to the motors when regenerative braking is used. This resistor was made from stainless steel tubing welded to stainless steel return bends. The tube varied from $^1/_{32}$ inch to $^1/_{16}$ inch in wall thickness.

Figure 13 shows details of welded joint used. The tubes were placed on the ends and a short piece of $^1/_{16}$-inch wall tubing pressed inside to form a chill ring.

Figures 14, 15 and 16 show views of some of the generator parts used in the locomotives. The frames, rotors and fans of these generators were fabricated by means of arc welding.

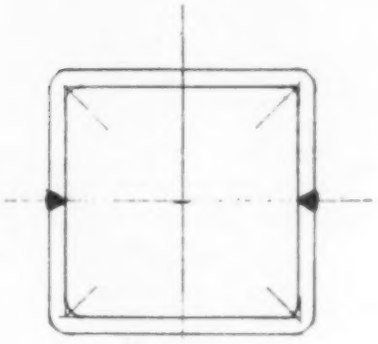


Fig. 7—Box Section Forming Vertical and Diagonal Members of the Side Trusses

Fig. 8—½-Size Cab Underframe Bolster Under 250,000-Lb. Load (Corresponding to 1,000,000-Lb. Buffing Load on Full-Size Bolster)

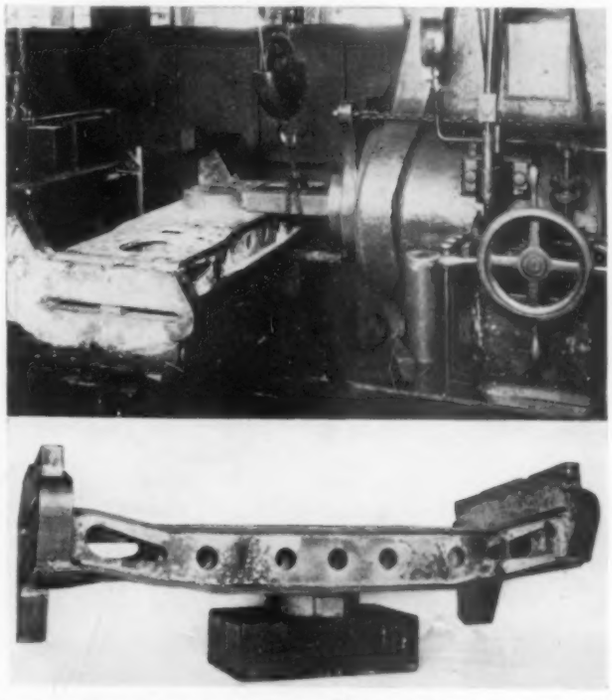


Fig. 9—Loaded Side of ½-Size Bolster After Being Tested Under 387,000-Lb. Load (Corresponding to 1,512,000-Lb. Buffing Load on Full-Size Bolster)

Fig. 6—Vertical Girder Member of Cab-Frame Structure, After Compression Test

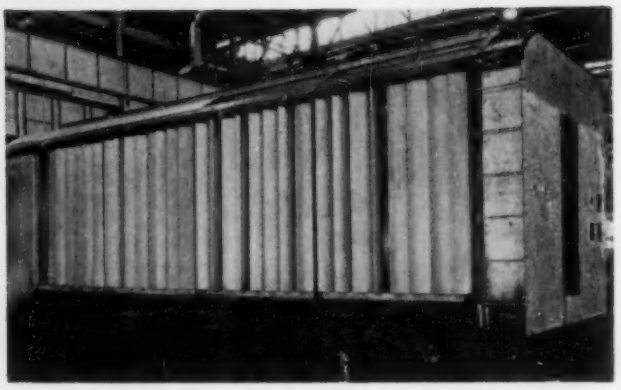


Fig. 10—"B" Side View at Rear, Showing Condenser-Inlet Louvres

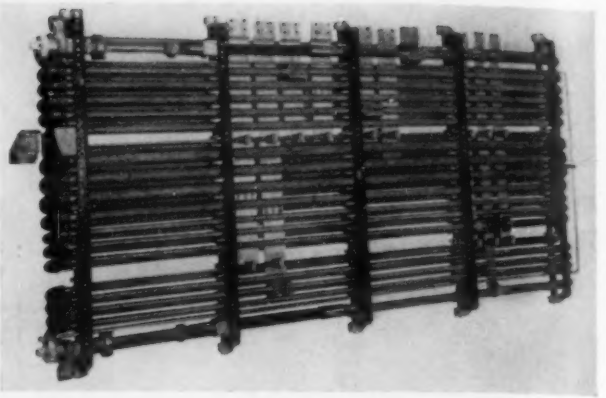


Fig. 12—Transportation Water-Cooled Braking Resistor, Weight 994 Lb.

V—FOUR CONDENSER FANS

Figure 17 shows one of the four condenser fans. These fans supply air for cooling steam condensers. The blades are of aluminum riveted to a steel spider. The arms of the spider are of nickel steel arc welded to a 35 carbon steel hub. In welding this fan, the hub and spider arms were preheated to 150° C. before welding. After welding, the structure was annealed at 725° C.

Fig. 11—Section Through Louvre

VI—POWER PLANT PIPING

The steam operating pressure for the steam turbine on these locomotives is 1500 pounds 900° F. Carbon moly steel was used for the high pressure steam line, and carbon steel pipe was used for the high pressure water lines and the low pressure steam lines. All steel pipe lines above 1 inch were arc welded. The smaller diameter pipe lines were gas welded where butt joints were used.

On 2-inch pipe and over, a welding ring was inserted on the inside of the pipe at the butt joints. Figure 18 shows an etched section of a welded pipe joint with a welding ring in place. It was found the preparation, such as detailed in Fig. 19, gave the best results. From

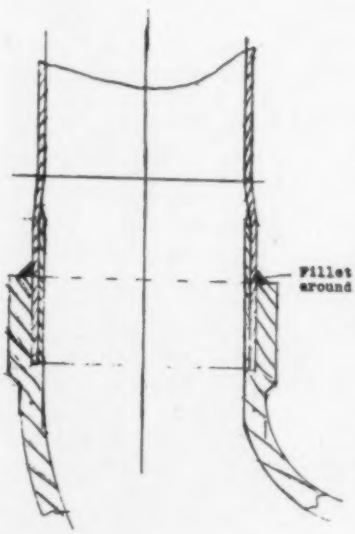


Fig. 13—Details of Welded Resistor Joint

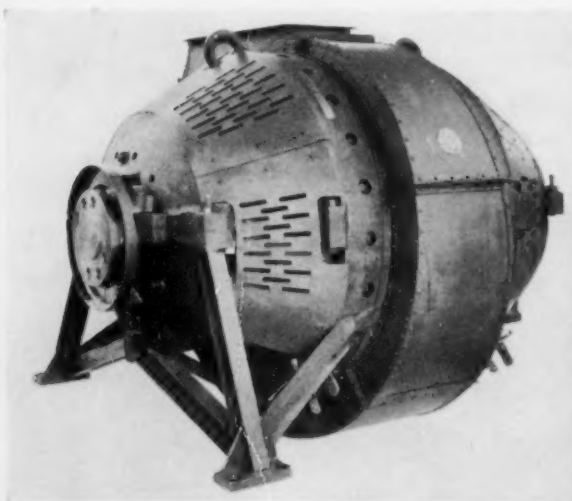


Fig. 14—Direct-Current Traction Generator, Without Coupling and Oil Pipes. Oblique Gear-End View

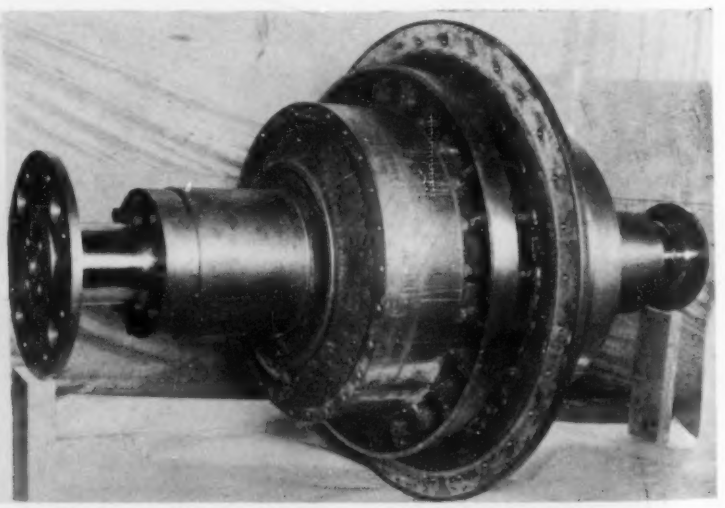


Fig. 15—Armature Spider and Shaft, with A-C Generator Coupling Flange Installed for Direct-Current Generator. A-C Generator-End View

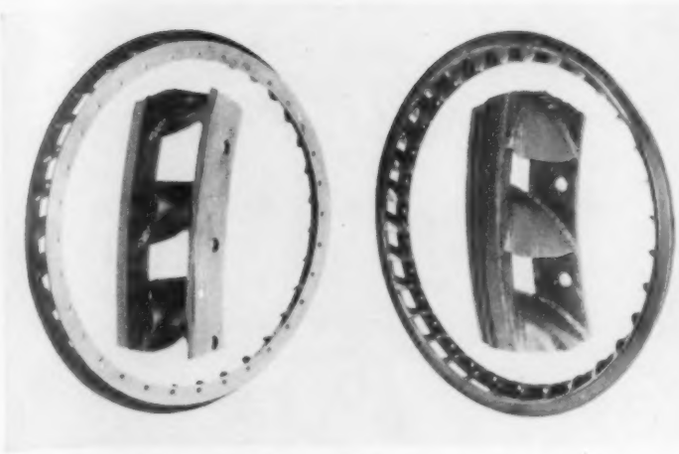


Fig. 16—32-Blade Armature Fan for G-E Direct-Current Traction Generator. (Bolting-Flange and Blade-Side Views)

Fig. 17—Condenser Fan Mounted on Its Gear Box

sections cut up and etched, too large a shoulder was found undesirable where the pipe shoulder butted against the projection on the chill ring.

On pipe between one inch and two inch diameter, a sleeve type joint was used, as shown in Fig. 20. We used arc welding wherever possible and our welders have developed considerable skill in welding small diameter pipe. Wherever a chill ring could not be used on butt pipe joints, the acetylene torch was used, as there was less likelihood in burning through the pipe.

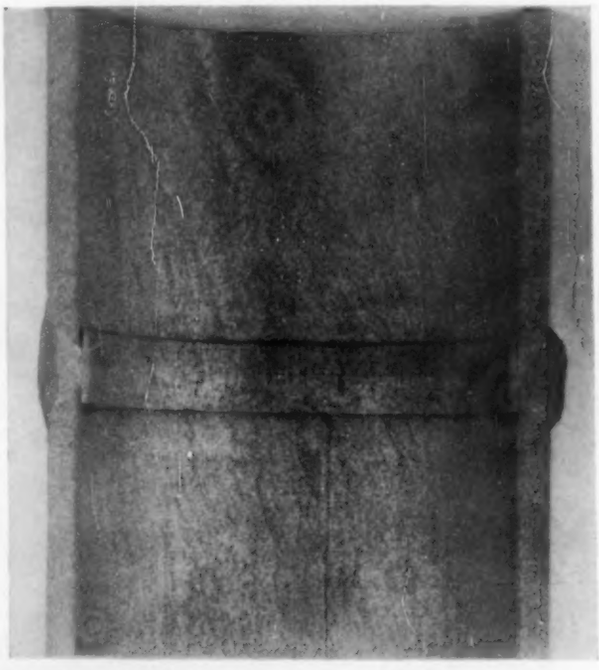


Fig. 18—Etched Section of Pipe Joint with Welding Ring in Place

All joints on carbon moly pipe were preheated to 200° C. before welding and held at that temperature during the welding operation. A carbon moly electrode was used and the welds were made with pipe in position as it was not possible to roll the pipe. After welding, the joints were given a local stress relief anneal.

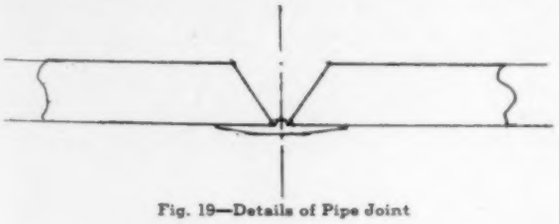


Fig. 19—Details of Pipe Joint

Figure 21 shows a general view of the top of the locomotive showing piping and apparatus in place.

The exhaust steam lines from the turbine to the condensers were fabricated from plates rolled and formed to shape and welded. Copper expansion joints were placed in the exhaust lines wherever required. These expansion sections were gas brazed to the steel pipe. A section of this pipe is shown in place in Fig. 4.

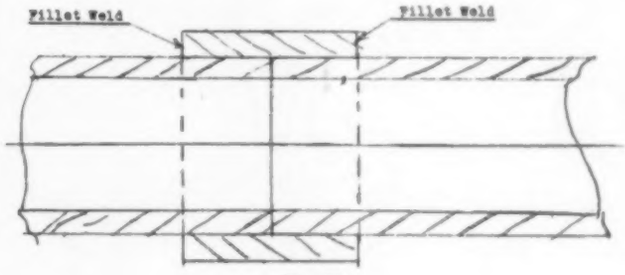


Fig. 20

The use of arc welding in the design of these locomotives enabled the designer to save some weight which was desirable and to fabricate sections that would not be possible with some of the other methods of construction. In addition to the parts mentioned in this paper, arc welding was extensively used in building the turbines, turbine gears, gear cases, boiler condensers, evaporators, feed water heaters, etc.

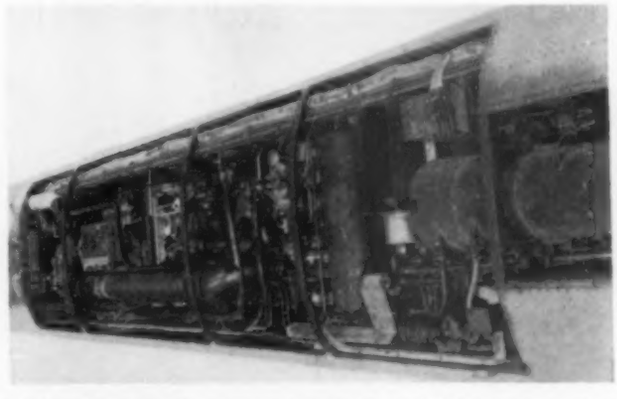


Fig. 21—Steam-Electric Locomotive, Without Hatch Covers. Oblique Top View Toward No. 2 End, of Apparatus in Apparatus Cab

ARC WELDING

THE STAINLESS STEELS*

By EDWARD J. BRADY†

THE purpose of this discussion is to correlate our present-day knowledge and experience in welding stainless steels into a logical, reasonable and easily understood outline for practical use. Engineers and metallurgists, who write highly technical articles concerning this subject, sometimes forget that we are still dependent upon the welder and shop foreman for the actual fabrication of welded structures. Because even a simple discussion of stainless steels immediately involves the subject of metallurgy and heat treatment, the shopman has found it difficult to obtain a practical working knowledge of these steels. The physical characteristics of stainless steels are vastly different from those of mild steel and it is a matter of great concern for the welder to have a knowledge of the fundamental principles involved. With the increasing demand by industry for uniform, high-quality welds, the welder is rapidly becoming our front-line metallurgist and heat-treater where the fabrication of metals are concerned.

The term "stainless steel" could easily be interpreted as meaning one particular steel, whereas it actually applies to over one hundred varied analyses. Although the element chromium is present in all stainless steels, the combination of chromium and nickel is used to form the basis of the most popular stainless types. While the stainless steels may be separated chemically into the straight chromium and the chromium nickel steels, they can be studied more easily when separated into metallurgical groups.

In the study of metallurgy, it is found that all metals, when etched with acid and magnified under the microscope, show certain characteristic grain formations. These grain formations have been classified by metallurgists who have found them to be an index to the physical and chemical as well as the mechanical properties of the metal. By good fortune, the numerous stainless steels in common usage today reveal only three characteristic grain formations. Therefore, by placing these steels in their metallurgical category, an immediate index to their physical characteristics and welding procedure is obtained.

CLASSIFICATION OF STAINLESS STEELS

In the following table all stainless steels have been classified according to their metallurgical structure:

Martensitic
Straight chromium steels under 16% Cr.

Ferritic
Straight chromium steels over 18% Cr.

Austenitic
18% chromium–8% nickel and steels of higher alloy content containing both chromium and nickel. Additional alloying elements may be used such as molybdenum, columbium, etc.

As may be seen from the foregoing table, there is no sharp line of demarcation between the martensitic and ferritic groups, in so far as the chromium content is concerned. Steels with chromium contents ranging from approximately 16 to 18% may fall into either group depending upon the carbon content. The higher carbon content would of course tend to make the steel martensitic.

The table below places the most commonly used stainless analyses in their respective metallurgical groups:

Martensitic
4–6% chromium (with or without 1/2% molybdenum)
12–14% chromium
15–16% chromium

Ferritic
16–18% chromium
23–30% chromium

Austenitic
18% chromium– 8% nickel
18% chromium– 8% nickel (with columbium)
18% chromium–12% nickel (with 2–4% molybdenum)
25% chromium–12% nickel
25% chromium–20% nickel
35% nickel–15% chromium
60% nickel–15% chromium
80% nickel–20% chromium

Steels in the austenitic group having an alloy content of 25% chromium–20% nickel or higher are generally known as "heat-resisting" rather than "stainless" steels. It should also be noted that steels containing less than 11% chromium are not classed as "stainless," but in order to present a more comprehensive picture of the chromium and chromium-nickel alloys they are included for discussion in this paper.

MARTENSITIC GROUP

Stainless steels in the martensitic group possess the following physical characteristics:

1. Less coefficient of expansion than mild steel.
2. Thermal conductivity 1/2 to 2/3 that of mild steel, depending upon the chromium content.
3. Electrical resistance 3 to 5 times mild steel.
4. Magnetic.
5. Drastic air hardening properties.

With the knowledge of these basic physical properties it is possible to work out practical welding procedures.

* Presented at March 31st meeting, Milwaukee Section, AMERICAN WELDING SOCIETY.
† Manager of Stainless & Alloy Division, The McKay Company.

Little difficulty is encountered with warping when welding these steels because the coefficient of expansion is less than that of mild steel. It is questionable whether the lower thermal conductivity has a marked effect with respect to warping when preheating procedure is used.

The electrical resistance is considerable higher than mild steel and increases proportionately to higher chromium content. Electrode manufacturers are cognizant to this fact and electrodes of 12% chromium content and higher are shorter in length in order to reduce resistance heating. Although 20% higher welding currents than would ordinarily be used are recommended for the 4–6% chromium electrodes, no perceptible increase in resistance heating is present.

The martensitic chromium steels are magnetic and therefore are subject to magnetic arc blow which may be minimized by the same methods employed when welding mild steel.

Outstanding among the physical characteristics of the steels in this group are their drastic air-hardening properties. To illustrate the extent to which they possess this property, a 5% chromium steel with 0.20% carbon air cooled from 1575° F. will have a tensile strength of 212,000 pounds with an elongation of 9%. The same steel heated to the same temperature, but allowed to furnace cool, has a tensile strength of 75,000 pounds with an elongation of 32%. Increasing the chromium content reduces the tendency to air harden. Welds made with 15 to 16% chromium alloy will show considerably less air hardening than those made with 12 to 14% chromium and proportionately less than the 4–6% chromium steels.

Preheating is the generally accepted method of counteracting the air-hardening effect. Temperatures of 300 to 500° F. should be employed although some fabricators use temperatures up to 800° F. The weld should be completed at these temperatures and immediately placed in the annealing furnace without allowing to cool.

Field welding precludes the use of an annealing furnace and therefore other means must be used to produce ductile welds. Addition of columbium to 4–6% chromium steel has been used in the parent metal as well as in the weld deposit and a marked reduction in air hardening is effected. The 12% and 16% chromium steels are produced in non-hardening grades by the addition of 0.20 to 0.40% aluminum.

Where operating conditions permit, the austenitic stainless electrodes are becoming increasingly popular for welding straight chromium steels. A weld deposit analysis of 25% chromium and 20% nickel will produce excellent results with steels of 4% chromium and upward; 25% chromium and 12% nickel will also produce satisfactory results. Preheating is unnecessary providing the work is not permitted to become too warm during the welding operation.

FERRITIC GROUP

Stainless steels in the ferritic group have the following physical characteristics:

1. Less coefficient of expansion than mild steel.
2. Thermal conductivity $^1/_2$ that of mild steel.
3. Electrical resistance 5 to 6 times mild steel.
4. Magnetic.
5. Non-hardening.

Regardless of the fact that the alloys in this group are non-hardening, essentially the same welding procedure is used as employed for the martensitic steels. Weld deposits in the chromium range of 18 to 30% will exhibit very little ductility due to grain growth which cannot be eliminated because these alloys are not susceptible to heat treatment. To illustrate the effect of grain growth in cast structures the following comparison is drawn with a forged or rolled section. A rolled plate containing 23 to 30% chromium will have a maximum tensile strength of 100,000 pounds with 25 to 35% elongation as compared with a casting of the same analysis that will show a maximum tensile strength of 80,000 pounds with 2 to 5% elongation when both are in the annealed condition. Annealing has no effect upon reducing the grain size of the casting, whereas a forged or rolled section will possess ductility by virtue of mechanical working.

Many mills are producing these stainless alloys with additions of nitrogen which reduces grain growth and improves the grain structure of the heat-affected zone adjacent to the weld. Electrode manufacturers are also introducing nitrogen into the core wire although it is recommended that where conditions permit an electrode of 25–20 or 25–12 analysis be used.

AUSTENITIC GROUP

Austenitic stainless and heat-resisting steels are characterized by the following physical properties:

1. Coefficient of expansion 50% more than mild steel.
2. Thermal conductivity $^1/_2$ that of mild steel.
3. Electrical resistance $6^1/_2$ to 9 times mild steel.
4. Non-magnetic.
5. Non-air-hardening.
6. Melting temperature approximately 200° F. less than mild steel.
7. Carbide precipitation.

Allowance should be made for the greater thermal expansion of these steels by increasing the width of gap between plates. It is logical to expect increased warping difficulties due to the greater expansion although it has been argued that this is offset by the low thermal conductivity.

At least 20% less welding current is recommended than would ordinarily be used if the same job were mild steel. Three physical characteristics of the austenitic steels combine to form the basis for low current requirements. Low thermal conductivity localizes the heat from the electrode arc along the weld joint and prevents a rapid dissipation of heat throughout the plate. High electrical resistance and lower melting temperature of the electrode combine to further reduce the current requirement.

A smooth-running arc with low spatter loss may be expected with austenitic stainless electrodes because they are non-magnetic and therefore are not subject to magnetic arc blow.

Austenitic stainless steels possess a property known as "carbide precipitation" or "intergranular corrosion" which takes place when these metals are cooled slowly between the temperatures of 1550 to 900° F. This phenomenon takes place when the cooling rate between these temperatures is longer than approximately sixty seconds.

Carbide precipitation in the weld deposit is not a serious problem providing the weld metal is a "balanced alloy" and the carbon content is under 0.07% carbon. However, these stainless steels receive their maximum ductility and corrosion-resisting properties by rapid cooling from the critical temperature and every precaution should be taken to allow the weld metal to cool as rapidly as possible. This may be accomplished by running the weld in stringer beads (no weaving), small diameter electrodes, and low welding current.

For welded structures operating in service at temperatures above 700° F. it is recommended that additions of

columbium be added to the base metal and the electrode. Columbium additions of approximately ten times the carbon content will prevent carbide precipitation.

Austenitic stainless electrodes are increasing in popularity for welding alloys other than stainless steel. Mild steel electrodes have their limitations for welding high carbon alloys and combinations of dissimilar metals. Providing that the proper stainless alloy is used, welds of high tensile strength and ductility can be obtained with a great variety of metals. It is well to bear in mind that stainless weld deposits are only strong and ductile when they are in the austenitic state. Should sufficient dilution of the weld metal with parent metal occur and the weld analysis is lowered beyond 17% chromium–7% nickel, brittle welds will result. For this reason electrodes having at least 25% chromium–12% nickel and preferably 25% chromium–20% nickel should be used.

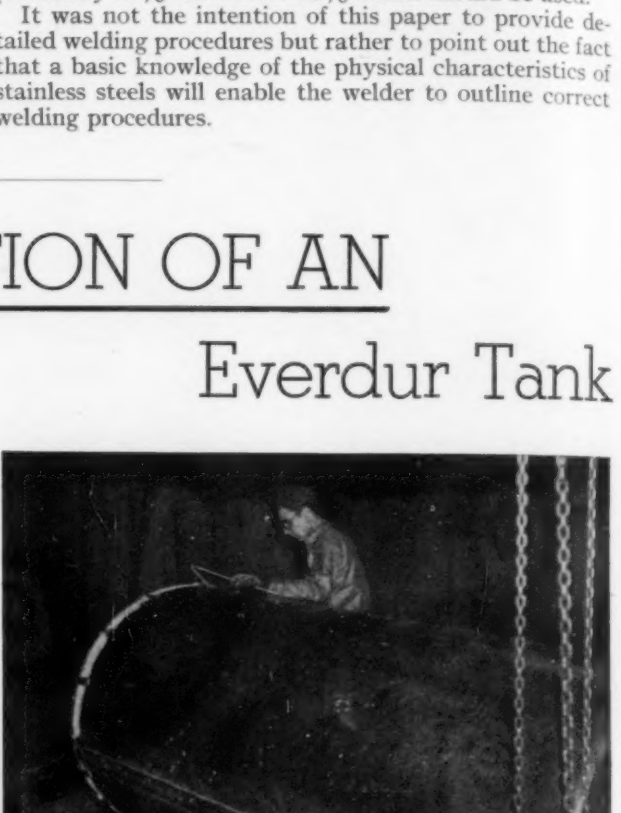
It was not the intention of this paper to provide detailed welding procedures but rather to point out the fact that a basic knowledge of the physical characteristics of stainless steels will enable the welder to outline correct welding procedures.

WELDED FABRICATION OF AN Everdur Tank

By L. T. BENOIT*

STRENGTH AND DURABILITY FEATURE A HOT WATER HEATER WELDED BY THE DOUBLE-LAYER METHOD

EVERDUR metal and oxyacetylene welding have proved to be an unbeatable combination in the fabrication of hot water storage tanks. Everdur metal assures that these tanks will resist the corrosive action of hot water and its active constituents almost indefinitely; oxyacetylene welding assures that the tanks will be sufficiently rugged and durable to withstand the high and varying water pressures. The following description of the procedures used in fabricating one of these tanks should prove helpful to those who have occasion to use Everdur for other types of pressure vessels and storage tanks, such as condensers, stills, retorts, mixers and autoclaves.

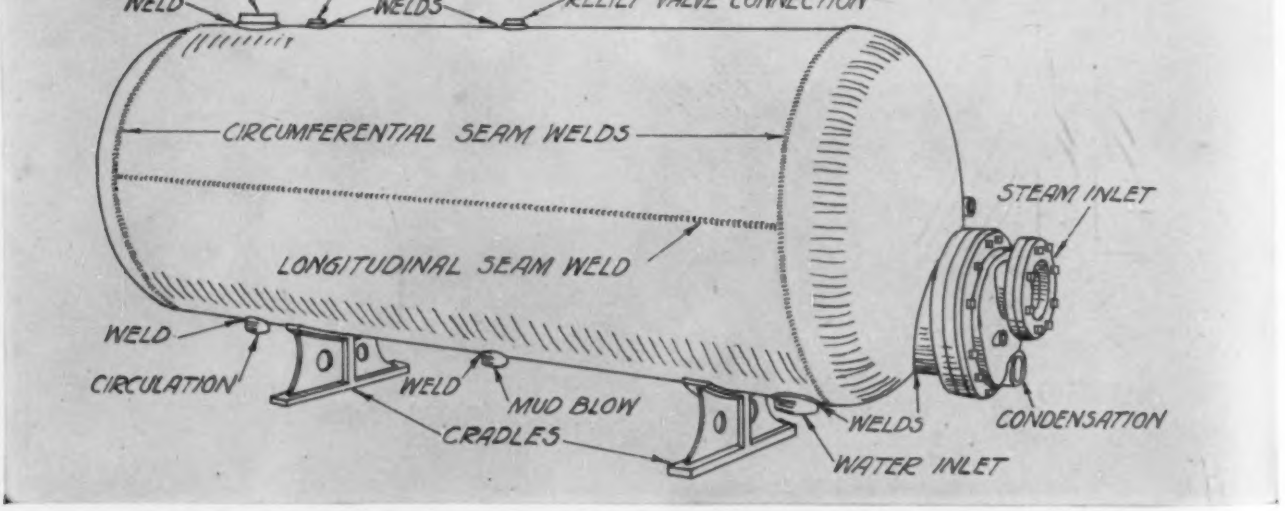


The Tank Was Rotated During the Joining of the Head and Shell So That the Operator Maintains a Constant Position

ADVANTAGES OF EVERDUR

Before the tank in question is described, it might be well to review briefly the characteristics of Everdur which make it particularly well adapted for the construction of hot water heaters. Everdur metal is a non-ferrous

*The Linde Air Products Company, Boston.



This Sketch Indicates the Location of the Oxyacetylene Welds Used in the Fabrication of an Everdur Hot Water Tank

copper-rich alloy of copper, silicon and manganese. It is much harder than commercial copper and has the strength of mild steel. It is available in the commonly used forms, such as pipe, tubing and rolled plate, is readily cast, and can be successfully welded.

Particularly important, however, is the corrosion resistance of Everdur. In many localities the water supply contains gases and, sometimes, other substances in solution which make the water actively corrosive, especially when heated. Many an ordinary steel water shell heater has had to be replaced after only a few years' service. Oftentimes the cost of removing an old heater and installing a new one is more than the actual cost of the heater itself. For this reason, there has been a demand for an alloy suitable for heater shells which combines strength, corrosion resistance and good weldability.

The Double-Layer Method Was Used for Welding Tank Seams. Here, the Operator Is Depositing the First Layer

Everdur fills these requirements so well that Everdur tanks are, in fact, "good for the life of the building."

Another equally important reason for using Everdur is the total elimination of rusty or "red" water which, if present, makes it next to impossible for laundries to turn out snow-white work.

TANK CONSTRUCTION

Shown in the accompanying sketch and illustrations is an Everdur hot water tank designed specifically for laundry service. This tank is approximately 4 ft. in diameter and 7 ft. long. The flanged and dished heads are of $^{3}/_{8}$ in. thick material, while the shell is $^{15}/_{64}$ in. in thickness. Oxyacetylene welding was used not only for making the longitudinal and circumferential tank seams, but also for joining all the connections to the tank, as indicated by the sketch.

WELDING PROCEDURE

Longitudinal and circumferential seams were made by means of the double-layer or two-layer method of welding. Single-vee 80- to 90-deg. joints were first prepared by grinding. Next, both sides of the scarf were painted with a special Everdur welding flux mixed into a paste. (In the photographs, the white appearance of the joints is due to this flux coating.) Everdur welding rods were also painted with flux after they had been heated slightly so that the flux would adhere.

One of the Clips Used to Align Accurately the Head and Shell Is Clearly Visible in This Close-Up. Whiteness Along the Joint Is Due to the Flux Coating

Welding was done with the forehand technique using a Blowpipe equipped with a No. 10 Head. The flame adjustment was neutral, or very slightly oxidizing. As is required in the two-layer method of welding, the vee was only partially filled during the first run. After an entire seam had been welded in this manner, the second layer was deposited right over the first layer without further preparation or fluxing except on the welding rod. No welding rod was wasted since the operator welded each new rod onto the stub of the partially consumed rod.

ALIGNING THE TANK HEADS

The method used for assuring an accurate spacing and positioning of the heads and shell was particularly interesting and is clearly illustrated in the accompanying photographs. It consisted of placing clips at regular intervals around the entire circumference of the tank seam. Each of these clips was made out of two short lengths of bar steel through which a nut and bolt were fastened to permit drawing them together.

After the scarf or groove had been prepared for welding, the edge of the vee was nicked every 8 or 10 in. where each clip was to be placed. Thus, the thickness of the bolt holding the clip together did not force the head away from the shell as the metal tightened up during welding. The nuts were always placed on the outside of the tank so that as the operator approached each clip, his helper could unscrew the nut and knock the bolt through, thus removing the clip. In this way the clips were saved for other jobs.

It will be observed from the illustrations that the operator maintained a practically constant position when making the weld between the head and shell. This was possible because a helper at the other end of the tank rotated the tank as the weld progressed.

THE ALL-WELDED DIAGONAL GRID

Applied to Plane and Spatial Structures*

By ANANT H. PANDYA and R. J. FOWLER†

THE most important result of arc welding when applied to steel structures is to produce a monolithic action between the various members connected together. The continuity thus obtained is a great asset from the economic point of view, as it tends to reduce moments and forces acting on the component parts of a load-bearing structural system.

The plane and spatial grids which form the subject of this paper are fully monolithic and are therefore hyperstatic or statically indeterminate systems.

Before considering the more complicated spatial structures, the plane grid (suitable for floors and flat roofs) will be examined, the spatial structures being merely an extension of the fundamental cooperative properties of the flat grid. The best way of approaching the solution of a monolithic grid system is, first, to assume simple support conditions and independence of action for all grid members, and then to superimpose the effects of the indeterminate forces and moments to restore continuity or internal restraint. This would follow from the principle of superposition which states that the effect produced upon an elastic structure by a number of forces and moments which act simultaneously, is the same as the algebraic sum of the effects produced if the forces and moments are assumed to act separately.

Plane Grid.—The grid under consideration comprises essentially a diagonal system of beams (usually having the same cross section) which are arranged in two parallel sets equally spaced and intersecting at 90° or nearly so, and rigidly connected at the junctions or nodes. This layout gives, in all cases, beams of varying span, and therefore of varying rigidity, if treated as independent of each other. When connected monolithically, those more rigid give great relief to those more flexible, and thus tend to equalize the moments and shear forces on all beams.

Referring to Fig. 1, this illustrates a typical diagonal grid bay supported on walls, columns or main beams along the boundaries only. (The shorter side of the bay is divided into three and the longer into five equal divisions.) It will be observed that the beams intersecting at the internal grid nodes not lying on an axis of symmetry would, if independent of each other, deflect by a different amount under symmetrical loading. In fact, however, these deflections at any node must be equal, which means that at every non-axial node equalizing forces act between the intersecting beams. There is, also, at the edge nodes the condition of equal end slope angles for both intersecting beams, which results in the occurrence of equalizing moments. In addition to the above forces and moments which arise from the flexural rigidity of the individual beams, there are torsional equalizing moments acting at internal non-axial nodes arising out of the condition that at any such node the twist angle of one beam must be equal to the slope angle of the beam it intersects. It may, however, be mentioned here that these torsional effects are quite negligible in practice when ordinary rolled-steel sections are used as grid members.

It will be observed from Fig. 2 that all the grid beams are subjected to moments and shear forces which tend to attain a uniform maximum value, thus illustrating the true cooperative action between the grid beams. It will also be noticed that for any given layout the actual spans and loading can be varied without the necessity of a new calculation. This leads directly to the possibility of achieving standardization of calculations which are independent of the variables, span and load, and which once made can be applied to a variety of conditions. Furthermore, the selection of the size of grid beams can also be made in a few minutes from the maximum moment factor for a given layout.

Single Pitch Grid Roof.—For roof spans exceeding 50 feet it is common in normal design to make use of space frames, arches, trusses, etc., to support the roof covering, and the superimposed loads due to snow, wind, etc. In effect the depth of construction is increased in order to evolve a practical and economical design.

For monolithic grids the same results can be obtained by folding a plane grid to form a ridge along the center line and two gable ends with horizontal ties as shown in Fig. 3.

The grid, instead of being made up of interlacing straight beams, now consists of a number of cranked beams which are fully continuous at the cranking points and are capable of transmitting moments from one side of the crank to the other.

From the moment diagram in Fig. 4, it will be observed that cranking the plane grid introduces virtual elastic supports for grid members at ridge nodes which are, in their nature, similar to internal equalizing forces acting upward on the grid beams and downward on the inclined lattice or rhombic girders formed by the grid beams and ridge and eaves members. These imaginary supporting forces reduce the moments and shear forces on the grid beams very considerably, and transfer the superimposed loads to the actual points of supports along the boundaries by means of direct forces in the members.

The methods previously described were only for very simple cases. Their application can, however, extend to much wider fields and can, indeed, embrace almost all sizes and shapes of floor and roof constructions met with in normal practice.

Plane Grids.—For single bays the sides of the bay forming the boundaries can be divided into two, three, four,

*The authors of this paper, reproduced here in brief form, received Second Grand Award, $11,397.06, in the $200,000 Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, in which savings of $1,600,000,000 were shown available to industry by wider application of arc welding. The original paper contains 19,000 words, 46 drawings and 56 photos.

†Engineers, Diagrid Structures Ltd., London, England.

Fig. 1—Layout of Plane Grid

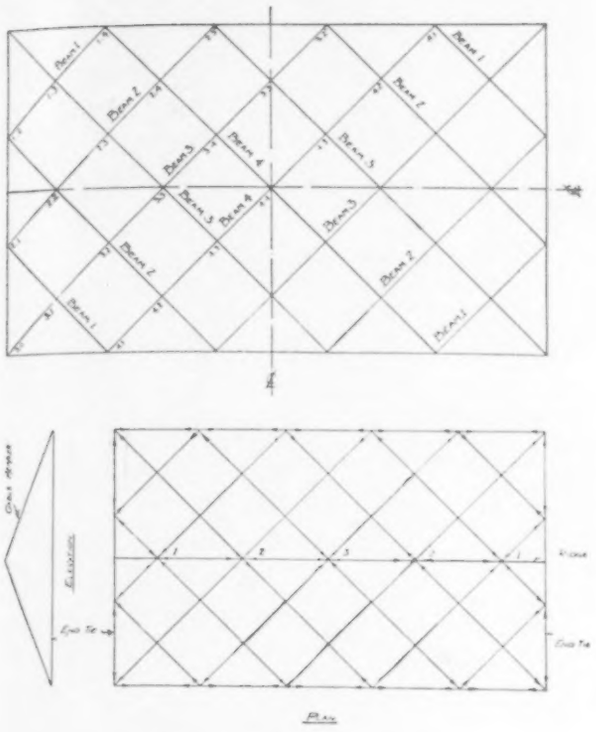


Fig. 2—Moments and Shear Forces on Plane Grid

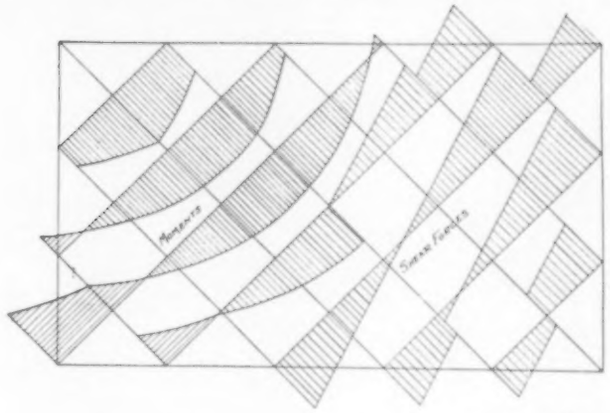


Fig. 3—Layout of Single Pitch Roof

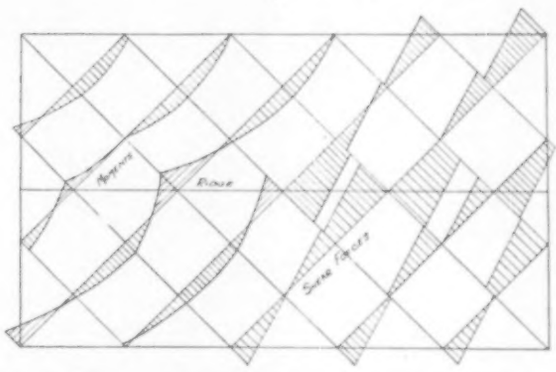


Fig. 4—Moments and Shear Forces on Single Pitch Roof

five or even six equal parts, the aim always being to provide short corner beams (beam 1 in Fig. 1) and an angle of intersection as near to 90° as possible. Sides of square bays are, however, best divided into three equal parts which are found to be most economical in practice.

An important step in the development of monolithic grids is the application to continuous grids. There is a marked similarity to mushroom or flat slab layout. This is accentuated by the fact that a set of crossed cantilevers is used with each column, which appears to be comparable to drop panels and column heads in mushroom design. The grid beams, on the other hand, are similar to the cross or two-way reinforcement commonly used in reinforced concrete flat slab construction.

This brings us to the most important and in many ways a revolutionary development of the monolithic grid. All-welded steel diagonal grids have proved to have all the advantages of two-way concrete flat slab construction, with none of its disadvantages. The common practice in the design of the latter is to follow certain empirical regulations which place many limitations on the layout of panels in plan. The grids under consideration are entirely free from these restrictive rules, and are more adaptable to practical requirements. They exploit the two-way reinforcement and drop panel ideas in the most economical manner, and all moments and shear forces are analyzed with great accuracy.

Spatial Grids.—As in the case of plane grids for floors, the application of folded or curved grids can embrace almost any size or shape of spatial roof structure.

The effect of folding is to stiffen up the monolithic plane grid along ridge and valley lines. This removes many of the restrictions on the grid layout, and makes it possible to span distances up to 300 feet in the shorter direction (parallel to ridge and valley lines) and almost unlimited distances in the other direction.

It is difficult to exaggerate the significance of the above statement for modern requirements arising out of the developments of methods of transportation, as also industrial manufacturing processes call for economical structures providing large unobstructed spaces. The monolithic spatial grids bring the fulfilment of the demand for large spans within bounds of practical economy, as available materials can now be utilized with maximum advantage.

In conclusion, we shall review briefly a few of the special advantages of the spatial grids under consideration:

(*a*) There is a complete absence of bracings, tie rods and other similar members below the planes of the roof structure. (*b*) The sizes of members, being substantially larger than those common in normal trusses, reduce the area of painting by as much as 40% in many cases. (*c*) By the use of ordinary rolled-steel sections available on the market, almost any spans ordinarily required can be covered economically. (*d*) The roof structure, because of the arrangement of members, is capable of resisting wind and other horizontal forces. (*e*) The spatial grids are better suited to withstand aerial attacks, which must be a serious consideration in the case of hangars, factories, garages, railway stations, etc., which usually expose a vast expanse of roof surface and constitute an easy target from the air. (*f*) The storage space and cubic capacity of the structure are increased substantially because of the absence of columns, ties, bracings, etc., and goods can be stacked from floor level right up to the underside of the roof planes.

Erection.—As with the designing and detailing aspects of welded steelwork, it is necessary, in order to reap all the advantages available, to consider erection apart from the practice that has developed in riveted work. It is hoped to show that this has been achieved in the case of the diagonal grid structure as built today.

Fig. 5—Factory at Bristol, England, Showing the Use of Diagonal Grids

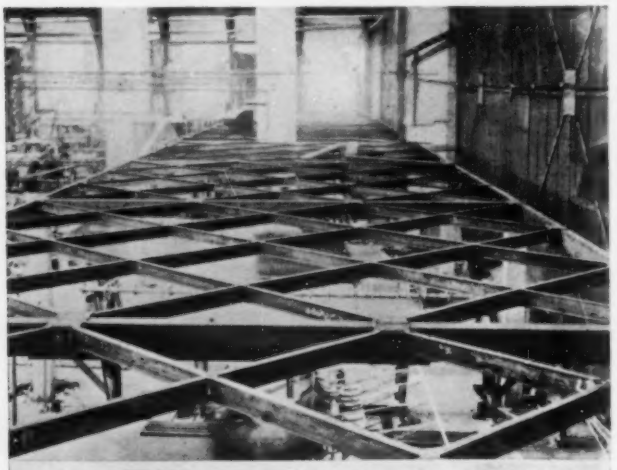


Fig. 6—Open Air School at Manchester, England, Having a Roof Consisting of Eleven Panels of Diagonal Grid Construction

Originally, the structures were erected piece small or nearly so; that is, the stanchions were first erected and plumbed. Then the eaves and gable edge channels, followed by the grid joists and finally the purlins and boom bracings were lifted into position individually and welded.

The great proportion of the welding was carried out in the air, with the welders perched on ladders, sitting astride members, or standing on improvised scaffolding.

A considerable number of scaffolding poles was essential to maintain grid members in their correct vertical positions until the welding of the grid nodes and ridge and valley booms was complete.

To eliminate delay, an attempt was made to increase the welding to be carried out under comparatively comfortable conditions, viz., at ground level.

In the case of flat grids, the whole structure may be thus fabricated, and all that is then required is to lift it up to just above its final level, erect the stanchions and to bolt or weld it to them.

Erection of the spatial grid or roof is slightly more complicated. Each roof slope is assembled and welded complete on the ground with its eaves channels, gable channels, grid members and purlins on trestles at suitable working height for the welders i.e., about 2 ft. 6 in. above ground level. On completion of the slope it is lifted into position on the stanchions and temporarily propped until the adjacent slope is similarly lifted, and the two are then welded together at the ridge.

Thus, the erectors and welders work mainly at ground level, and considerable improvement results in the quality of the work. But a further improvement has been made, overcoming the difficulties of lifting and propping the individual slope which are large flat areas of steelwork.

A further development still, in the case of smaller structures of the multiple bay type, has been to assemble the whole structure at ground level and to lift it in one piece. The great stiffness of the diagonal grid structure enables this operation to be carried out quite rapidly and safely.

Data regarding some of the grid structures designed and erected after January 1, 1937:

1. Factory, Bristol (see Fig. 5).—The structure consists of a row of square floor panels (8 panels 22 ft. 6 in. square and 10 panels 20 ft. square) supported on two rows of 8 in. x 8 in. precast concrete columns spaced at 22 ft. 6 in. and 20 ft. centers. The grids were considered continuous in one direction and were designed for a superimposed load of 100 lb. per square foot.

Erection Procedure: (*a*) Grid beams and edge beams prepared in the shops of the steelwork contractors; (*b*) the edge beams and edge connection details were assembled and tack-welded together in square panels on trestles under their final positions; (*c*) grid beams assembled and tack-welded; (*d*) welding completed. It was found that distortion of the grid panels was completely eliminated by welding the butt welds and fillet welds connecting the grid beams on both top and bottom flanges, from the center outward; (*e*) panels lifted onto precast reinforced concrete columns by one erection pole and ragbolted in position.

2. Open Air School, Manchester (see Fig. 6).—The structure consists altogether of eleven roof panels of varying sizes, the largest individual panel being 26 ft. 8 in. square and the smallest 26 ft. 8 in. x 20 ft. All are supported on steel stanchions at the panel corners. Some of the grids were cantilevered out to form a canopy and others were made continuous in one direction.

Erection Procedure: (*a*) All sections were sent direct from the mills to the site without preparation. All preparation was carried out on site by acetylene-gas cutting, except in the case of the splicing plates which were prepared in the shops. The remainder of the erection was completed as described in the previous example. Figure 6 is a view of the structure in which the method of lifting the complete panels with four erection poles is clearly shown. The stanchions were erected after the panels had been raised, the panel was then lowered to them and bolted temporarily until the welding between the stanchion caps and the grid was completed.

3. Drill Hall, London (see Fig. 7).—The structure is a single pitch roof 82 ft. x 52 ft. in plan resting on concrete edge beams at eaves level. The absence of internal tie rods and bracings, etc., is very important because the structure is to be used for purposes which necessitate a ceiling higher in the central portion than at eaves level.

Erection Procedure: (*a*) All material including plate for connection details was despatched to site from stock, to be gas cut to length and shape. (*b*) As the steelwork was carried on a concrete wall all round the periphery, it was thus a few inches longer than the internal dimension inside the end walls. It could not then be fabricated in complete slopes on the ground, but portions were omitted from the ends of the slopes, which were erected separately after the slopes were in position.

One lifting pole only was used to erect each slope, and was placed in the center of each. During lifting, a deflection of approximately one foot was obtained as the ropes attached to the center of the slopes carried more weight than the wide angle ropes attached to the slopes nearer their ends. Careful inspection of all welds under these conditions of severe stress showed no indication of failure.

4. *Ice Rink, Blackpool* (see Fig. 8).—The structure consists of a single pitch roof of 133 ft. span with one semi-circular end covered by a half cone. The longer dimension in plan is 150 ft. and there are no internal supports of any kind. Along the boundaries at eaves level the structure is supported on concrete columns and in the center the apex of the half-cone provides a virtual support for one end of the pitched grid along the ridge.

Erection Procedure. (*a*) All material except the grid beams and main members for the half-cone section were prepared in the shops. The latter were sent direct to the site from the mills, and were cut to length by oxy-acetylene gas cutting. (*b*) Temporary erection towers were used to support the members during erection and welding. They were built up from light section material bolted together in order that they could be dismantled after use. Timber platforms were provided at the top of the towers and a timber seat was made in the center of each platform to engage the grid members or connection detail supported. The towers were portable in order that they could be moved as the erection advanced to further intersections.

Experimental Research on Welded Diagonal Grids: A comprehensive program of experimental research work on diagonal welded steel grids was carried out between November 1935 and April 1936. All the tests were made under official supervision in Great Britain, with the primary object of obtaining a check on the analytical methods used for obtaining stresses and deflections.

Tests on three models of welded steel grids 4 ft. 3 in. square were carried out at the City and Guilds Engineering College of the Imperial College of Science and Technology, under the supervision of Prof. A. J. S. Pippard. In all the three models the grid beams were $1^1/_4$ in. x $^1/_4$ in. flats, excepting the corner beams which were made from 2 in. x $^1/_4$ in. flats. The edge beams were 2 in. x $^1/_2$ in. flats in all three models. The first model grid was open, the second one covered on one side by a continuous $^1/_4$-in. top plate, and the third one had this $^1/_4$-in. plate placed at the bottom in the corners instead of at the top. The floor plates were tack-welded to the grid beams, so that they formed "T" sections.

The loading was applied by means of canvas bags filled with lead shot, which were borrowed from the Royal Aircraft Establishment, Farnborough. Deflection readings were taken at a number of different points with Ames' dials.

The calculated deflection and positive moment values were, in every case, greater than those obtained in the tests, thus demonstrating the conservative character of method of grid stress analysis and the additional margin of safety provided by welded diagonal grids.

Tests on a full size floor bay 20 ft. square with 6 ft. 8 in. cantilevers on all sides and supported on 4 columns at 20 ft. centers, were carried out under the supervision of the Building Research Station of the Department of Scientific and Industrial Research.

No stress measurements were taken during testing, but the deflection readings obtained for open and concrete grids were substantially lower than those derived analytically. Among other things, the test indicated the suitability and strength of this type of construction for floor structures where stiffness and minimum depth of construction are required. A total load of 220 tons was applied on the structure (equivalent to 940 lb. per sq. ft.) without causing failure.

Tests on a 37 ft. x 30 ft. folded grid roof structure were also carried out under the supervision of the Building Research Station of the Department of Scientific and Industrial Research.

Fig. 7—Drill Hall in London, England, Showing the Use of Diagonal Grids in Roof Framing

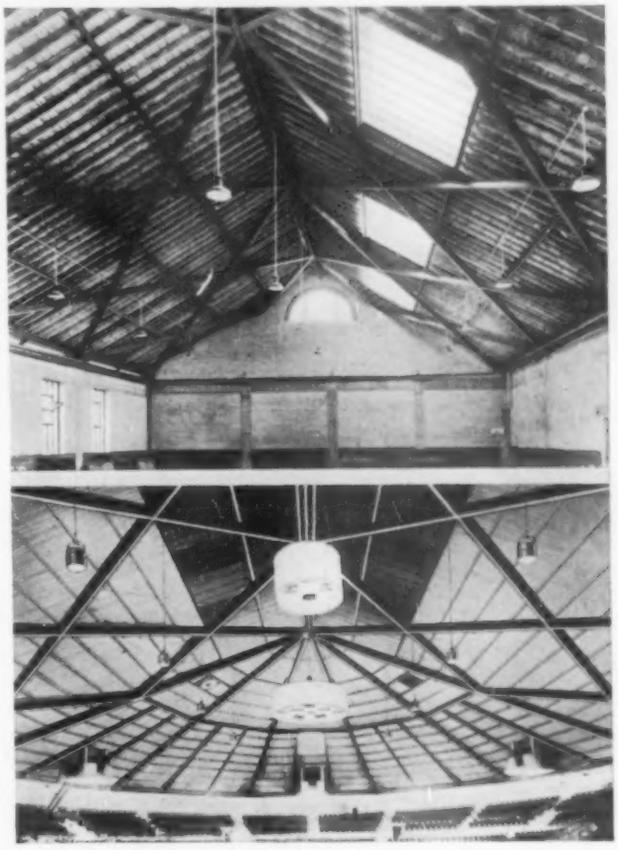


Fig. 8—Ice Rink at Blackpool, England, Having Diagonal Grid Roof Frame

In plan, the structure consisted of 3 x 4 division grid, the 30 ft. side being divided into three equal parts and the 37 ft. side into four equal parts. The grid was folded into four planes with a central ridge and two internal valleys each 30 ft. long.

The design load was 95.5 lb./sq. ft. and the structure was loaded to 363 lb./sq. ft. without reaching the yield point of the material. The test had to be discontinued at this stage due to the settlement of the supports.

The gross savings accruing to industry through the general adoption of the design were described.

An attempt to assess these savings is made here on the basis of information obtained from "Statistics of the Iron and Steel Industries" published in 1937 by the British Iron and Steel Federation of Great Britain.

The latest available figures on the production of structural sections in the principal countries of the world are given below:

	Country	Tonnage	Year
1.	United Kingdom	1,726,400	1936
2.	United States	2,897,000	1936
3.	France	476,500	1936
4.	Germany	5,528,300	1936
5.	Belgium	382,800	1935
6.	Luxemburg	401,300	1936
7.	Japan	481,900	1935
8.	Poland	269,600	1935
9.	Russia	122,000	1933
10.	Sweden	44,000	1936
11.	Canada	34,600	1935
12.	India	132,800	1936
		12,497,200	

It will be seen that approximately 12,500,000 tons of finished steel sections (joists, channels, angles, tees, etc.) suitable for structural purposes are produced annually. Of this total, however, only a part would be used for buildings, the rest being used for ships, railway coaches, bridges, etc. In the absence of any definite information available on the exact percentage of the total used for buildings, it will be assumed that about 50% of this is utilized for this purpose, i.e., 6,250,000 tons.

Then again, the question arises as to the number and size of structures where the diagonal grid could be used profitably. It has already been stated that the field of application of this type of design is very wide indeed, and an estimated tonnage of 3,000,000 would seem quite a conservative figure where the diagonal grid could be suitably and usefully employed instead of prevailing types of structural arrangements.

The gross value of this steelwork at a low unit price of £20 ($100) per ton would be £60,000,000 ($300,000,000). It is reasonable to assume that the adoption of the all-welded grid design would lead to an average saving of 20% in cost. From this, then, the gross savings accruing to industry work out at £12,000,000 ($60,000,000).

In conclusion, it must be stated that these economic advantages of the diagonal grid design are in addition to the many others which have been fully dealt with in the original paper.

The Uses of Oxygen and Acetylene in the Refinery*

By HENRY JOUETTE†

THE use of oxygen and acetylene in the refinery today has enabled our modern engineers actually to put into service the things that were only dreams twenty-five years ago.

Today, high pressures and high temperatures in refining oil have made it necessary for us to change our method of pipe construction and refinery equipment.

The refinery is made up of many different departments, all of which are necessary for the manufacturing of gasoline and other refinery products. Being independent within itself, the refinery has its own power and light plant, water-treating plant, ice plant, boiler houses, clay burning plant, air compressor equipment, blacksmith shop, boiler and tank fabricating shop, carpenter shop, machine shop, paint shop, pipe shop, steel barrel manufacturing plant, car repair shop, instrument shop, and last, but by no means least, the welding shop.

The use of oxygen and acetylene has a very distinct part in the operation and maintenance of these various departments of the refinery. The uses of oxygen and acetylene can be divided into three main divisions; namely, New Construction, Maintenance and Salvage and Demolition, each of which has a valuable and important place.

NEW CONSTRUCTION

I want to take up, in the order named above, the various ways oxygen and acetylene are put to use in the refinery. I will begin with "New Construction." This field calls for a wide use of oxygen and acetylene, from the cutting of reinforcement rods to the completed job. Practically all pipe work, manifolds and pipe headers are constructed in the welding shop, as well as the field, by the use of the oxyacetylene cutting torch. Structural steel fabrication and erection is simplified by the use of the oxyacetylene welding torch. Pumps, pump parts and pump bases are constructed in the welding department of the refinery, also safety guards, guard rails, pipe hangers, instrument panel frames, stack uptakes, water, fuel, and storage tanks, pump lubricators and water heaters.

High and low pressure steam lines are now of welded construction. In the erection of these lines, there is a certain amount of cutting and fitting done. All connections from the main lines are made by the use of a cutting torch. Most steam lines are more or less streamlined, so to speak, by the omission of all bulky screwed fittings. Insulation of these lines has been modified and improved, due to welding.

New oil and gas lines are constantly being constructed and because all gas lines are either just on top of the surface or underground, they have to be so constructed as to give the minimum amount of upkeep. The natural method for the upkeep of these lines calls for welding. Lines on the surface must be supported. These supports are fabricated from second-hand pipe by the use of the oxyacetylene cutting torch.

Pipe hangers and hanger lugs are often fabricated out of angle or channel iron, simply by cutting out the flange and heating and bending to the required shapes. Hanger bolts are often shortened or lengthened, as the job might require, and this, too, is done with the oxyacetylene process.

Yes, the oxyacetylene cutting torch has its place in the new construction going on in the refineries of today.

MAINTENANCE AND SALVAGE

That is sufficient for the new work in a refinery. After the completion of a job, it must be maintained. Oxyacetylene welding and cutting play an important rôle in this phase of refinery work, too, such as storage and tank repairs, removing old roofs and structurals, fabricating new roofs and bottoms in the field from stock sheets, cutting holes in roofs for vent and gage connections, the placing of safety guards around vents, keeping the fire protection equipment in first-class condition, which, by way of explanation, is an important item, foamite mixing chambers and piping, repairing steam lines to tanks, cutting and fitting steam heater coils, and repairing stair platforms and stair brackets.

I have mentioned sundry repairs made by the oxyacetylene cutting equipment just above, but I want to go a little more into detail on the importance of oxyacetylene cutting in the maintenance of steam, gas, water and oil lines.

As you know, of course, many of our pipe lines, especially the older ones, are not welded. Often it is deemed advisable to remove or reroute a pipe line. With the use of the oxyacetylene torch, this is not considered a

*Presented at the 39th Annual Convention of the International Acetylene Association, Houston, Texas, March 8, 9 and 10, 1939.

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major task. The pipe is merely cut in sections, taken up, all screwed collars and flanges cut off, and the ends torch beveled for welding. Connections are constantly being added to pipe lines. "Y" and "T" fittings are cut and fitted into the line for welding.

Often the older steam lines have to be taken out of service due to leaking threads and flanges. When this becomes necessary, every possible thread connection is cut out and welded. Since all steam lines are overhead lines, they have to be supported. These supports are made either of structural steel or second-hand pipe. In making pipe stanchions, the pipe is shaped and fitted with the cutting torch.

There is a great demand for oxyacetylene cutting in the maintenance of the grease plant and lubricating department of the refinery, such as repairing the old piping to and from the grease mixers. This is done by removing all threaded fittings and then welding. Grease strainers, safety guards, hand rails and heater coils are fabricated and installed in tanks; pumps and pump manifolds are repaired and remodeled by the use of the oxyacetylene cutting torch.

There still exist in the refineries today some of the old shell type stills that require constant repair. The oxyacetylene torch is indispensable for cutting out old patches and rivets for replacement with new ones, cutting holes in the stills for rivets, as well as repairing condenser boxes, coils and coil supports and repairing the vapor lines from stills to towers. Do not overlook the fact that pipe and pipe connections must be repaired and replaced in this type still and there is a constant demand for oxyacetylene cutting here.

Of course, there is not a department within the refinery that must be kept in first-class condition more so than the power plant and boiler houses. With the oxygen and acetylene tools, we are able to do this, as well as keep in first-class shape fuel gas, steam and water lines. Tubes are removed from boilers, fresh air fans and ducts to boilers are repaired, and pipe hangers are fabricated or repaired. In addition to this, instrument board frames, safety guards, water cooling system and turbines are also repaired with oxygen and acetylene tools.

Metal spraying is fast taking its place in the refinery, not only from a corrosion-resisting standpoint, but in many other ways. Many pump rods and turbine shafts are built up with stainless or high-carbon steel. Furnace burners that have to withstand an excessive heat are fabricated in the welding shop and then sprayed with a coat of aluminum. Tank floats are sprayed with stainless steel, aluminum or bronze, as well as exchanger heads and shells. Large bearing shells are sprayed before babbitting.

Hot oil pump sleeves and bushings, as well as many machine parts that show excessive wear, are hard surfaced by the use of the oxyacetylene welding torch.

What use would we have for the millions of gallons of gasoline turned out by the refinery each day if the tank cars weren't in shape to roll it away? Here, the oxyacetylene torch plays a most important part. In this department the cutting torch is used to remove running board bolts, rivets, holes for tank patches and rivets, burning out rivets in draft gear lugs, cutting out rivets in center plates, top and bottom. The rivets on the under frame must be cut off and out when they have to be removed.

The oxyacetylene equipment is one of the most used tools for repair work on the cracking stills. Considering the fact that the cracking unit has just recently emerged from the pioneer stage in the refinery, let me go into detail a bit about the importance of oxyacetylene cutting in the upkeep of this unit in connection with the refining of oil. All ruptured or worn-out tubes are cut out of headers. In order to remove ruptured or worn-out tubes from the furnace, the weld on the bushing first must be cut off, then bushing is heated and cooled to remove from header. The tube is cut off by the use of the straight line cutting torch just back of the header, leaving about four inches of tube to remove from header, this being done by splitting the short piece in about three pieces. The ferrule between the tube and header wall is then removed in a like manner, the same method applying on the opposite end. The tube is then ready to be removed. Coke that has accumulated between header and ferrule is removed by the use of a torch. New tubes are then placed in headers, ends rolled and then heated with the torch to be turned or flared for welding. The accumulated coke (or carbon) in the headers between tubes is removed by burning out with oxygen, using a torch only to start the coke burning. Other uses for oxygen and acetylene equipment in connection with the cracking unit are such as removing disk valves from bushings by heating with the torch, removing pipe work, cutting out bolts and nuts, removing and replacing coil supports in vapor towers, changing and repairing tower connections, changing and repairing reaction chamber connections, repairing gas separator connections, condenser box coils and supports, overflow water connections from condensers, making and installing new pipe connections, pump manifolds and headers in control houses, and repairing fresh air fans and ducts. The hot oil pumps often require the use of oxyacetylene torch when dismantling and repairing.

SALVAGING AND DEMOLITION

Having given you a few of the many uses of the oxyacetylene torch in the new construction and maintenance of the refinery, I want now to try to show you how important this equipment is for salvaging and demolition in the refinery.

Because of the fast changing of oil refining methods, we are constantly discarding obsolete equipment. Some of this equipment can be used on other jobs. Salvaging material in a refinery is by no means a small item. Material such as valves, pipe, pipe fittings, flanges, headers, manifolds, pumps, small tanks and towers, eye beams, channel and angle iron, are all salvaged. It might be of interest to you to know how fittings that are 3 in. or larger are salvaged by the use of the oxyacetylene cutting torch. This is done by cutting about one-quarter of the distance around the pipe, cutting or notching it out, then caving the pipe in, in order to remove without destroying threads in fittings. All usable pipe, after fittings are removed, is sent to the salvage department to be reclaimed for welding by cutting off threads and beveling ends with the torch.

After all usable material is salvaged from the old tanks, stills, towers structural and pipe work, mostly by the use of the cutting torch, that which is left is easily and economically demolished, cut to size, and disposed of for scrap material to be sold and shipped out of the refinery.

I have tried, in this paper, to give you a word picture of a few of the ways the oxyacetylene torch is used in the refinery today, but there are hundreds of other jobs done daily with this equipment that I couldn't possibly touch on in such a short time.

When we look back at the methods used a few years ago, and compare them with those used today, it is little wonder that oxyacetylene welding and cutting have such a broad application in our present-day refineries.

TECHNICAL TRAINING SCHOOL*

By H. F. SCHULTZ†

THE welding department was placed under the able supervision of professor William H. Rice, graduate of Case School of Applied Science, a man who has had wide experience in welding and in the machine shop. His was the task of setting up the welding courses. He chose as textbook "Steel," by Campbell, The Lincoln Procedure Handbook, The AMERICAN WELDING SOCIETY Handbook and THE WELDING JOURNAL, as supplementary material to keep the students in time with the latest developments in welding. Theory classes meet twice a week for one hour periods. Three hour lab classes meet three times per week, wherein students get actual practice in welding under expert supervision.

Theory for the first semester consists of a study of iron and steel as to production and processing. Emphasis is placed on the physical constituents of steel in preparation for courses later on which are more closely related to welding. "Steel," by Campbell is used as a textbook in this course. In the laboratory, the student learns the care and handling of welding equipment. He is expected to develop a fair ability as a gas welder in both the flat and vertical positions on low carbon steel and must be able to do a good job on welding cast iron and brazing. He learns to handle an electric arc machine and must successfully pass a qualification test on three-eighths in. low carbon steel plate in the flat position. Considerable time is spent in the heat treatment and identification of metals. Concurrently with this course the student is required to study forge and heat treatment of metals under Professor Soderstrom. Here he studies the reaction of steel to heat treatment and gets actual experience in the forging and heat treatment of steel.

The second semester theory consists of a study of strength of welds, stress concentration, warpage, cost estimation, flame cutting, flame hardening, different types of welded construction, characteristics of welding generators, the weldability of different metals and the technique used in welding each, and design of welded machinery and structures.

Laboratory is a continuation of the first semester. Students are required by the end of the semester to successfully pass qualification tests in all positions. These tests are carried on in much the same manner as they are in industry with the purpose of acquainting the students with the methods now in use so they can pass any qualification test they may encounter.

During the tests, students are divided into groups of two, one acting as welder, the other as inspector. As the weld is being made, the inspector observes and records any mistakes that may be made by the operator. This data is correlated with any flaws that may be found in the weld when it is tested. The test plates are cut into one inch wide bars across the weld and subjected to a series of tests to determine the strength and soundness of the weld. The student not only improves his own welding but also learns to judge the ability of other welding operators both by the manipulation of the torch and rod and by examination of the finished weld. This is experience that will serve him well should he ever become a welding inspector. Reports are written on each welding exercise. Aluminum, brass and iron base alloys are welded by both the arc and acetylene and comparisons are made as to the relative strength, ductility, appearance, speed, and cost of welding, etc. Reports are then written comparing the qualities of the welds made by each method.

The AMERICAN WELDING SOCIETY Handbook, with occasional reference to the Lincoln Procedure Handbook, is used as text for the third semester. At this time the student joins the AMERICAN WELDING SOCIETY as a student member and attends lectures by experts in the field of welding. He has much to gain by contacts he makes at the welding meetings.

The student welding organization is known as the A. and M. Branch of The Oklahoma City Chapter of the AMERICAN WELDING SOCIETY. Well informed speakers are invited to attend meetings of this Society and discuss some phase of welding. The student branch of the A. W. S. also has its social functions in the form of parties, dances and other amusements.

When the students joins the A. W. S., he receives a subscription to THE WELDING JOURNAL which is a valuable source of information about new developments in the field of welding.

Theory during the third semester is devoted mainly to welding design and special technique. The laboratory is an extension of the second semester, welding thicker plate, welding pipe and fabricating welded structures in production.

The final welding course, welding inspection and testing, has not been available as yet, due to lack of equipment. It is probable that this course will be available by the fall term of the current year. It will consist of the testing of welds and of welding operators by the visual method, and the testing of welds with photomicrograph and X-ray equipment.

In addition to regular welding exercises, students fabricate many welded structures and repair broken machine parts for other departments on the campus. In conjunction with welding cast iron, the student can now obtain actual experience in welding automobile heads which are supplied by a local auto salvage company. Heads which are satisfactorily welded will go back into service with the student's name stamped on it.

It can readily be seen that the School of Technical Training is not easy, consequently, those students only moderately interested in welding soon drop out and are replaced shortly by boys who are willing to work. After a semester of welding those who show little aptitude are advised to take up some other work.

The writer made a survey of his own class to find out what each student expected to do upon graduation. Three of them are expecting to be welding teachers and one a contractor. Several desire to become foremen or inspectors while others prefer technical sales and a few expect to have shops of their own.

Many of the regularly enrolled students are young men with the ambition of becoming welding engineers and, in addition to their regular welding curriculum, are taking up some phase of engineering and substituting engineering courses for technical courses where permissible.

Because the School of Technical Training is still young, and because of the lack of equipment mentioned previously, no one has graduated, so we have no record of what our students can do. They have, however, been given the necessary education and training and are hard workers. This is a combination which is hard to beat.

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*Extracts from a paper presented before the April Meeting, Oklahoma City Section, A. W. S.

†Technical School, Okla. A. & M. College.

ARC WELDING IN AIRCRAFT HEATING*

By L. J. CAREY and MARVIN WHITLOCK†

THERE are many items which contribute to the comfort of air travel and one of the prime and possibly the most important item is the heating of the cockpit and cabin. This heating is a year-around necessity, being used regularly in the winter and intermittently in the summer. It is not uncommon to encounter five or ten degree weather at high altitudes when the temperature on the ground is ninety-five or one hundred degrees above zero and for that reason it is necessary to have the heating system in operating condition all the year.

Methods of Heating.—Any system adopted to effect this heating operation must first of all be safe and must also be dependable, efficient, lightweight and easily controlled.

Refer to Fig. 1 for a perspective view of a modern airliner, the Douglas DC-3 or DST‡ showing the ventilation and heating system, and to Fig. 2 for a schematic piping diagram of the heating system.

The heating system as shown in Fig. 1 consists essentially of a boiler in the exhaust stack of the right engine, a radiator in the air-supply duct, a reserve water-supply tank in the right cargo compartment, and the necessary valves and controls to effect a safe and efficient heating operation. The boiler operates as a dry boiler, admitting water only when there is a demand for steam in the radiator. Under normal operation, the radiator is always full of steam and the reserve water tank supplies water to the boiler as needed to maintain the steam in the radiator. As the steam in the radiator gives up its heat to the air flowing through the radiator, the steam is condensed and flows back to the boiler.

It is quite apparent that the boiler is the very "heart" of the heating and ventilating system. A failure of the boiler will immediately cause the entire system to be inoperative, thereby resulting in an uncomfortable and

*The authors of this paper, reproduced here in brief form, received Fourth Grand Award, $7326.46 in the $200,000 Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, in which savings of $1,600,000,000 were shown available to industry by wider application of arc welding. The original paper contains 6300 words, 3 drawings and 5 photos.

†Foreman and engineer, American Air Lines, Inc., Chicago, Ill.

‡The DST is the sleeper version of the DC-3 and is otherwise practically identical.

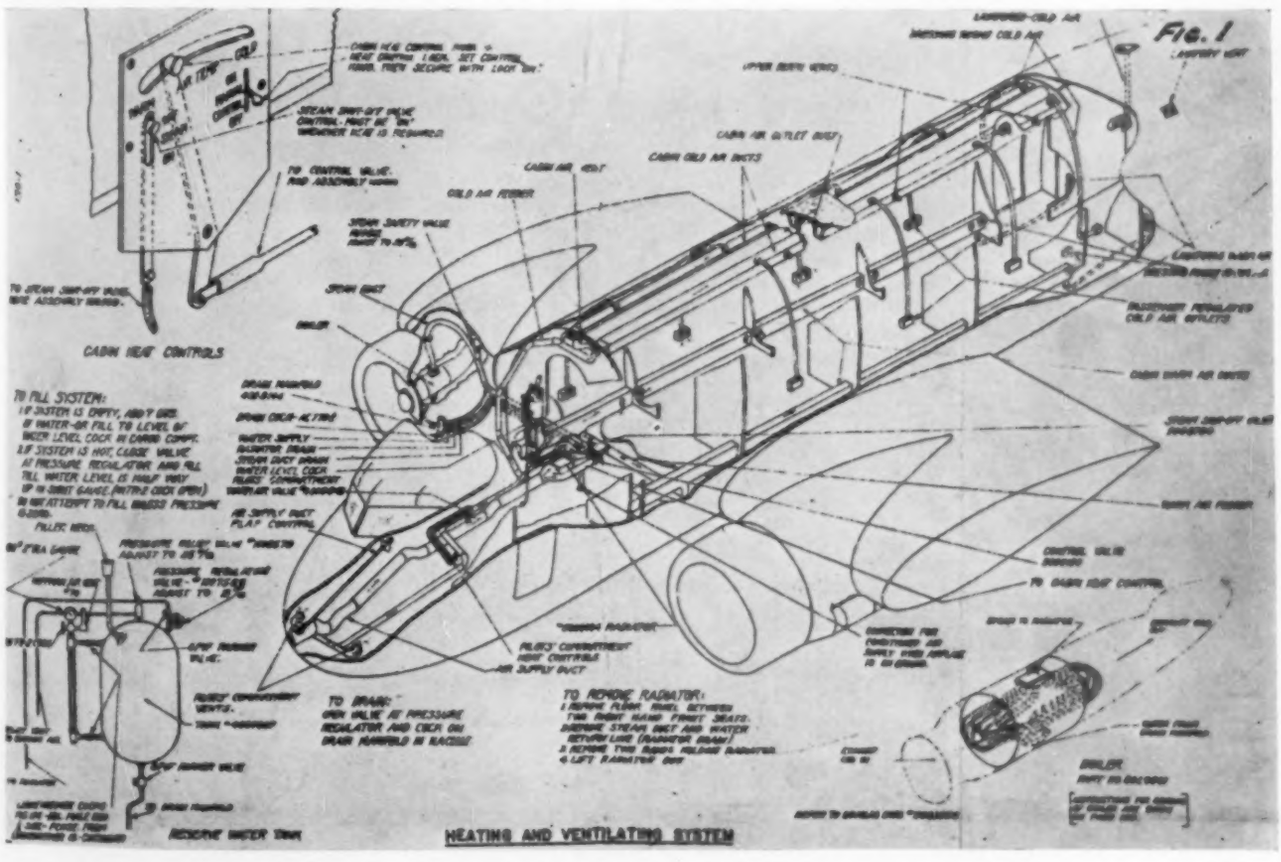


Fig. 1—A Perspective View of a Modern Airliner, Showing the Ventilation and Heating System

sometimes an unbearable temperature condition in the cabin.

Refer to Figs. 3, 4 and 5 for view of the bare boiler units. Figures 4 and 5 include the Douglas DC-2 "S"-shaped boiler units which are not included in this report. The DC-2 boilers have also given improved service due to the application of arc welding. A proportionate saving has been effected in the manufacture of the DC-2 boilers using the arc welder, but this paper is written on DST and DC-3 boilers only. Figure 3 illustrates the Douglas DC-3 boiler unit complete with upper and lower sumps and Fig. 6 illustrates the Douglas DC-3 boiler complete.

Troubles Experienced.—The conditions under which the boiler operates are very severe. One of the most serious conditions is that of expansion and contraction of the boiler tubes. The operation affords a cycle of quickly applied heat, normal heated operation, and back to a rapid cooling condition, all of which impose extreme expansion and contractive conditions on the metal.

Also the unit operates both as a wet system and as a dry system.

The above conditions are supplemented by an extreme vibration condition due partially to the fact that the boiler is mounted onto the exhaust stack which is in turn mounted on the engine.

In view of these requirements it is realized that the development of a satisfactory boiler was no small matter.

Steps Toward Improvements.—The first approach to the problem was that of changing the material of which the unit was made. Service tests were conducted over a period of approximately two years during which time every conceivable heat-resisting metal and alloy that was adaptable was tested both in laboratories and in actual installations.

The second approach was that of changing the design of the boiler. Several companies went to a great deal of expense to construct units of entirely different designs. The majority of these designs met defeat in their inability to provide sufficient heat, which is roughly proportionate to the area exposed to the exhaust flame.

Two facts of particular interest were established by this experimenting. One was that the tubular boiler shown in Fig. 6 was the only type boiler that had sufficient capacity to provide the required heat. The second fact was that Titanium Stabilized 18–8 stainless steel would give the longest service.

Improvements were noted as a result of service testing and redesigning, but in spite of these improvements, up until the summer of 1937, American Airline's boilers, which were of the latest type, were only averaging a mere seventy-five (75) hours on DST and DC-3 airplanes.

The boilers were being purchased from the aircraft manufacturers for approximately $195.00 each and could be repaired on an average of four times before being destroyed. Each repair cost approximately $20.00 including material and time required to remove the unit and to install a serviceable unit. This totaled $275.00 for five service periods or $55.00 per 75-hour period.

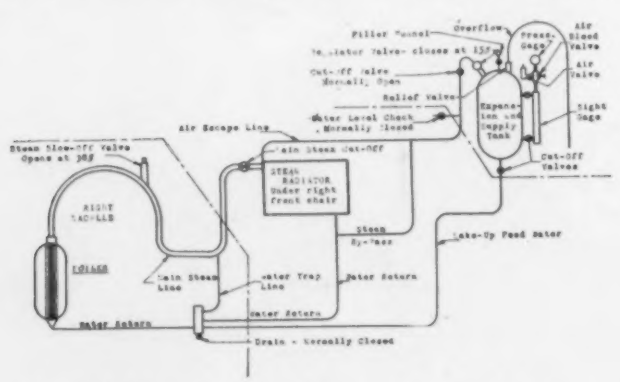


Fig. 2—A Schematic Piping Diagram of the Heating System

Fig. 3—An Airship Boiler Unit Complete with Upper and Lower Sumps

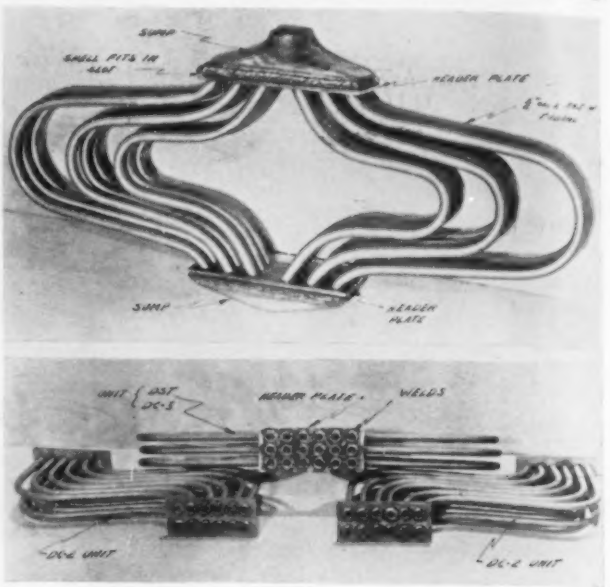


Fig. 4—Douglas DC-2 "S"-Shaped Boiler Units

As will be noted from Fig. 4 the method of fabrication is to bend the $^1/_2$-in. D.X. 065 W. stainless steel tubing into shape and to bring the tubing ends through the $^3/_8$-in. header plates. The tubing ends protrude on the opposite side from approximately $^1/_8$ in. The tubes are then welded to the top side of the header plate in somewhat of a rosette fashion, burning off the $^1/_8$-in. protrusion of the tubing. The weld starts out as a fillet weld but actually develops into a corner weld. The sumps are then welded into position on the header plates.

Due to differences in thickness of the materials it was necessary with the former method of fabrication, to preheat the lower side of the header plates while the tubes were welded on the other side. This procedure resulted in the ends of the boiler tubing being brought to a very high temperature and also necessitated two men to construct one boiler. It was also noted that there was a very high carbide precipitate when welded in this manner.

After welding, the unit is subjected to internal air pressure and submerged in water to test for leaks. Due to the inconsistency of the welds made by the former method, it was not uncommon to reweld a boiler seven or eight times before a satisfactory test was obtained. Of course, each time a boiler was rewelded, it was reheated, which took time and labor, and was detrimental to the metal.

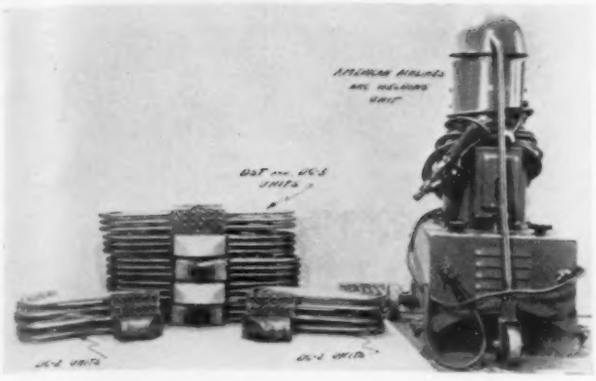


Fig. 5—Douglas DC-2 "S"-Shaped Boiler Units

Through close observation of boilers which failed in the field and which were returned, the authors noted that the majority of failures occurred in the form of a crack extending completely around a boiler tube in the immediate vicinity of the welds which also is in a section of the tubing bend. In other words, in heating the ends of the tubes and the header plates to the almost red heat necessary to effect the welding and due to the subsequent irregular cooling, the material was subjected to internal stresses under which no material could possibly give service especially when accompanied by such severe additional conditions.

At about that same time, which was in the late summer of 1937, the authors having some knowledge of the merits of arc welding, were very pleased to learn that arrangements were being made to install a 150-ampere machine on approval.

Soon after the machine was delivered, the authors began conducting some simple, practical tests of this process for our use in boiler construction. One of these simple tests consisted of welding four short pieces of tubing into a header plate in the usual manner. Two were arc welded and two were welded by the former method. The assembly was then placed in a hydraulic press in such a manner as to give a direct end load on the short pieces of tubing and a subsequent shear load on the weld. The two tubes welded by the former method sheared off at the weld, one under $2^1/_2$ tons and the other under $3^1/_2$ tons pressure. The two arc-welded tubes were loaded to $8^1/_2$ tons pressure at which load the walls of the tubing collapsed while the welds were unaffected.

Using the standard jigs and materials, the first boiler was welded in forty minutes (see Fig. 7). One small pinhole leak was found when the boiler was tested. This was easily repaired, and the total time for welding, testing and repairing was exactly one hour against eight hours for the previously used welding process.

The first boiler was put into service soon thereafter and operated continuously without repairs for a total of 420 hours, which was very gratifying in view of the 10- and 15-hour periods of the first factory experimental boilers, and the actual average of 75 hours on later boilers.

We constructed fifty more boilers in the same manner for service tests to further substantiate our beliefs. These fifty boilers averaged 376 hours of flying which was certainly a great improvement over the previous average of 75 hours.

In view of these very encouraging service tests, American Airlines began production of the arc-welded boilers in the fall of 1937 to replace all of the factory made boilers.

Results Accomplished.—In addition to the actual monetary savings which will be shown later, the service of the boiler was improved to the extent that during the winter of 1937–1938, the superintendent of maintenance received an average of only 13 trouble reports a month as compared to an average of 40 per month for the previous winter. This improved service was of an inestimable value from the passenger reaction standpoint, and American Airlines built up a nation-wide reputation as being the only company to have the heating system problems solved.

In a spirit of cooperation, American Airlines furnished drawings and sample boilers to four of its largest competitors, and to the United States War Department. The price quoted is $125.00 each instead of the former price of approximately $195.00 for practically the same boiler except welded by the old method. This decrease in price is no doubt due primarily to the decrease in man-hours required by the arc-welding process.

Savings Accomplished.—Economic gains that are accredited to the use of arc welding in the manufacture of airplane heating system boilers might be divided into two classes, namely: (1) Improved passenger comfort and its subsequent favorable reactions resulting in increased passenger traffic. (2) Actual monetary savings in the construction of boiler units.

During the past winter, American Airlines has enjoyed an indisputable reputation of having afforded the very best in passenger comfort and the use of arc welding has been the outstanding contributory factor.

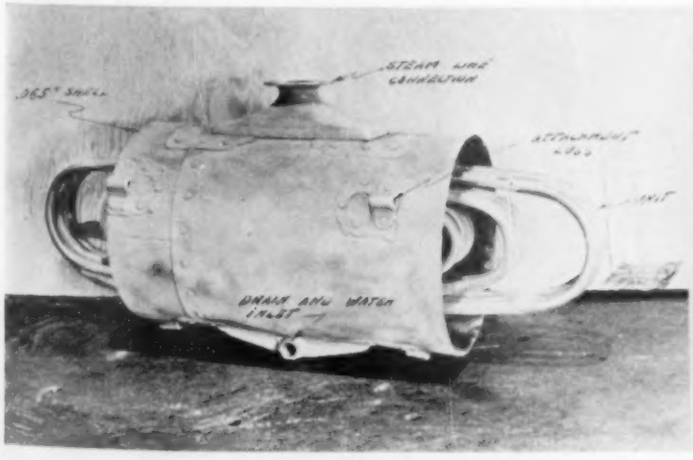


Fig. 6—Douglas DC-3 Boiler Complete

Fig. 7—First Boiler Welded in Forty Minutes Using the Standard Jigs and Materials

X-RAY AS A PRODUCTION AND Control Tool in Modern Pressure Vessel Manufacture*

By ORVILLE T. BARNETT†

THE outstanding method of non-destructive testing in use throughout the industrial world today is radiography. By means of short wave lengths of energy, with great penetrating power, differences in density of welds caused by porosities, slag inclusions or incomplete penetration may be found readily. In the main, two methods of radiography are widely employed; first, the X-ray, and second, the gamma ray. Pictures made by the first process are known as exographs. Pictures made by the second process are known as gammagraphs. In general, the X-ray is used for pressure vessel weld inspection and for a certain amount of testing inspection. Its practical limitation appears to be in the neighborhood of $5^1/_4$ inch thickness, where the penetrating power of the X-rays generated in a 400,000 volt machine together with our present means of identifying the rays after they strike the film appear to be on the point of incipient loss of detail.

In Fig. 1 is a general view of the X-ray machine as it is being used in the X-raying of an oil and gas separator with one man in the control cabinet and another man alongside. Due to the physiological effects of the X-ray, the men assume these positions where they are protected by the lead lining of the door of the cabinet, as well as the lead used to line the cabinet itself. Furthermore, the entire head is surrounded with lead to decrease the possibility of harmful X-radiation being scattered in the welding shop. On the control panel is an instrument for controlling the voltage which may be varied as required by the shell thickness. Included, too, is a rheostat for adjusting the milliamperage in the tube, the milliamperes usually being kept in the neighborhood of 10. A timing switch and necessary series starting and stopping switches complete the control devices. Now, walking around to the other side of the machine, we can see the rest of the equipment as shown in Fig. 2. There is the head itself, which contains the X-ray tube, two rectifying tubes, condensers and a transformer, all submerged in a bath of oil, which is surrounded in turn by cooling coils. These cooling coils are then attached to the radiator and water pump seen mounted on the vertical column that supports the tube arm. In the control box directly behind the control panel are mounted the various rheostats and switches necessary for the operation of this equipment.

* Presented at March 31st Meeting, Wichita Section, AMERICAN WELDING SOCIETY.

† Metallurgist, Black, Sivalls & Bryson, Inc., Oklahoma City, Okla.

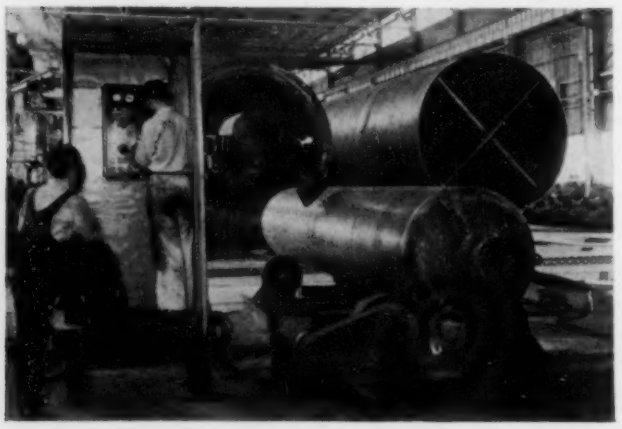


Fig. 1—General View of X-ray Machine

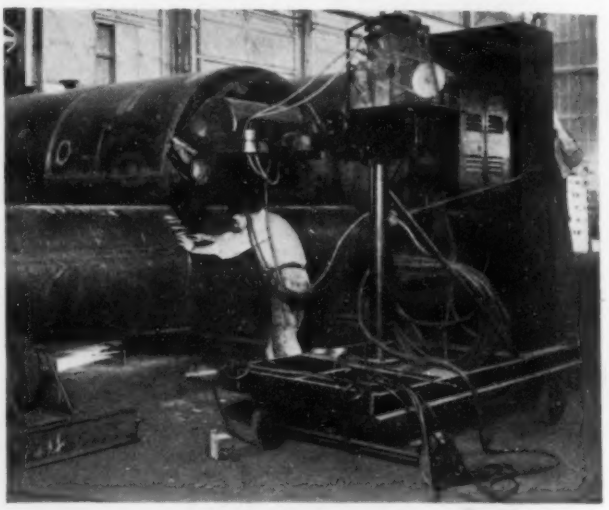


Fig. 2—X-ray Equipment

Turning to the vessel itself, we notice a number of strips of adhesive tape running across the welded seams. These attach the identifying numbers which are made of lead so that they will show on the finished exographs. In addition, penetrameters are placed at each end of the section to be radiographed so that an accurate check may be had upon the technique employed. More information about these penetrameters will be forthcoming when we get to them. Figure 3 represents a closeup of the strips of adhesive tape, showing their relationship to the identifying numbers and the seam itself.

Next, we take a look at the penetrameters as shown in Fig. 4, which were discussed earlier. As you can readily see, they are of two distinct types. Present seam preparation practice dictates the removal of the overlay bead for some code procedures as well as for some customer's specifications, whereas in other code practices, the overlay bead may be left in place.

Fig. 3—Close-Up of the Adhesive Tape Carrying the Identifying Numbers

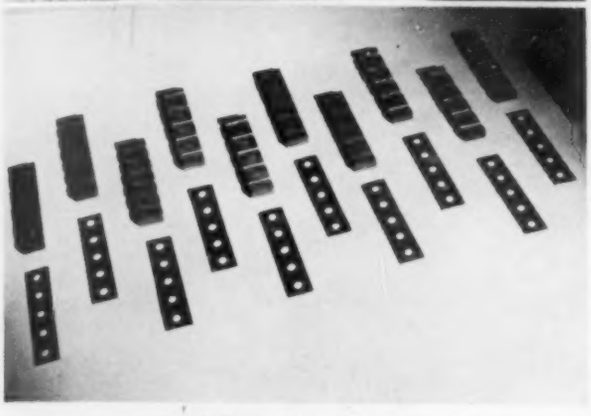


Fig. 4—View of Penetrameters

The thin penetrameters shown in the foreground are used where the overlay bead is removed. The thickness of the penetrameter itself is 2% of that of the thickness of the seam. In order to ascertain whether or not proper radiographic procedure was employed, these penetrameters are placed on the shell and must show clearly on the radiograph itself. Where the overlay bead is left in place, the thickness of the penetrameter is equal to the sum of the reinforcement inside and outside. Since the usual overlay bead is approximately $^{3}/_{32}$ inch high, the height of the penetrameter is twice $^{3}/_{32}$ inch, or $^{3}/_{16}$ inch. Into the penetrameter are milled slots, whose depth is 2% of that of the welded seam. The slots must show clearly when this type of penetrameter is used in order to guarantee proper kilo voltage, ampere-time relationship.

In the next figure, Fig. 5, is shown a drawing representing the passage of the X-rays through the welds and onto the film which is held in the cassette. Two points are shown, one marked "*A*" and the other "*B*," to denote the reason for the falling off in density of the film at the edges. Shells of very short curvature require a shorter film than do those of larger diameter where the falling off effect is very slight. This is due to the increased thickness of "*B*" compared to "*A*."

In Fig. 7, is shown the operator placing the cassette on the inside of the vessel between two portions which have been laid out to correspond with outside layout regions. Readily seen is the cassette placed right next to the weld and backed in turn by a lead sheet. The lead prevents secondary radiation from re-entering the film from the back and obscuring the desired details. Finally, the spring-mounted support that holds the cassette in place during the time of exposure may be seen.

The illustrations that have been presented up to this point are indicative of production radiographic inspec-

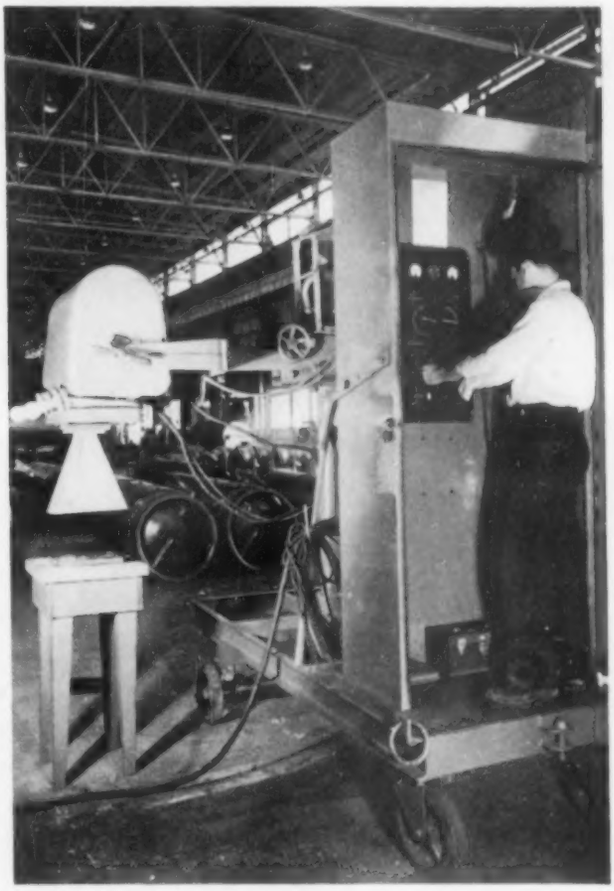


Fig. 6—Test Plate Being Radiographed

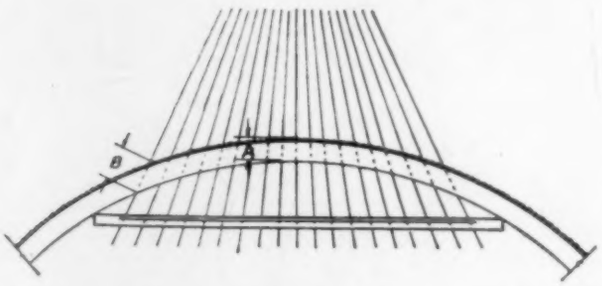


Fig. 5—Drawing Representing Passage of X-rays Through the Welds Onto the Films

tion. Because of the allowable joint efficiency that is given for radiographed seams where the vessel wall thickness is large and corrosion is not a factor, it becomes more economical to use a higher joint efficiency with radiographic inspection than to use a lower joint efficiency with resultant thicker plates and no radiographic inspection. Thus, the X-ray process is able to pay for itself in numerous applications.

Even were there no industrial uses for X-ray pressure vessels, it would be well to have this equipment available. No doubt its availability was hastened by the gaining popularity of radiographed pressure vessels. In fact, no boiler may be welded unless its shell seams are subjected to this type of investigation. However, it is in the

Fig. 7 (Top), Fig. 8 (Bottom)

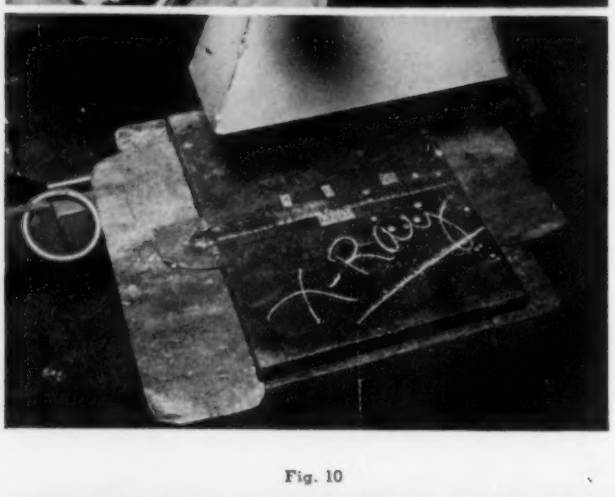


Fig. 10

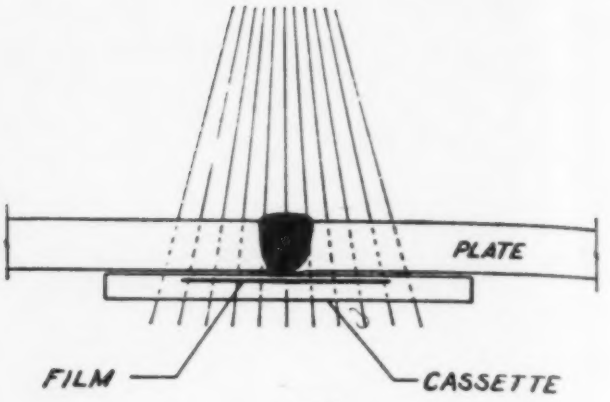


Fig. 9

Fig. 7—Operator Placing the Cassette on the Inside of the Vessel

Fig. 8—Close-Up of Test Plate Prepared for Radiographing

Fig. 9—Schematic Diagram for X-raying Test Plate

Fig. 10—Piece of Film Being Placed on the Inside of the Cassette

Fig. 11—Welded Seam in a Pressure Vessel

Fig. 12—Macrograph Showing Weld Not Chipped Before Welding on Reverse Side

Fig. 13—Radiographs Containing Slag Inclusions

Fig. 11

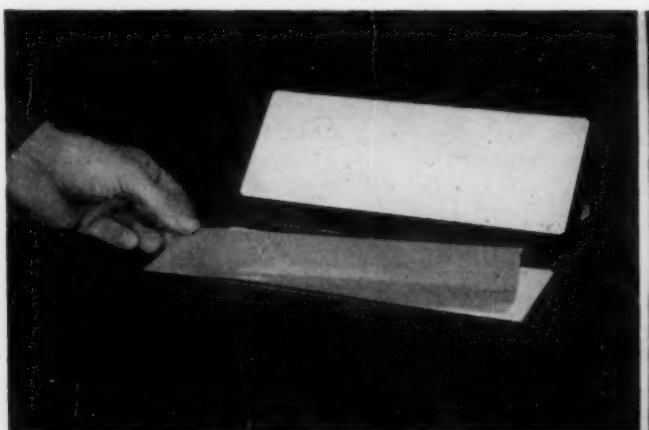
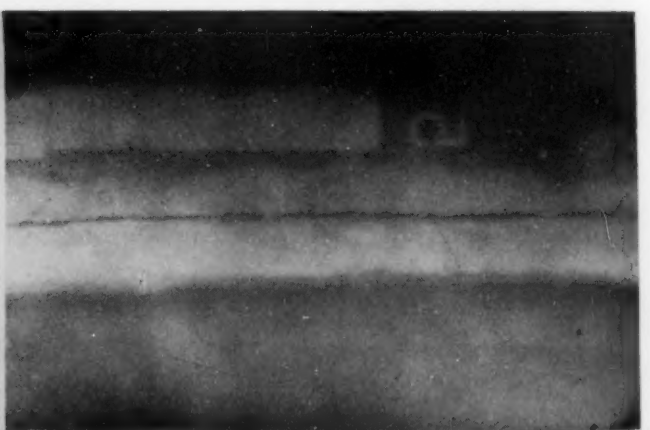


Fig. 12



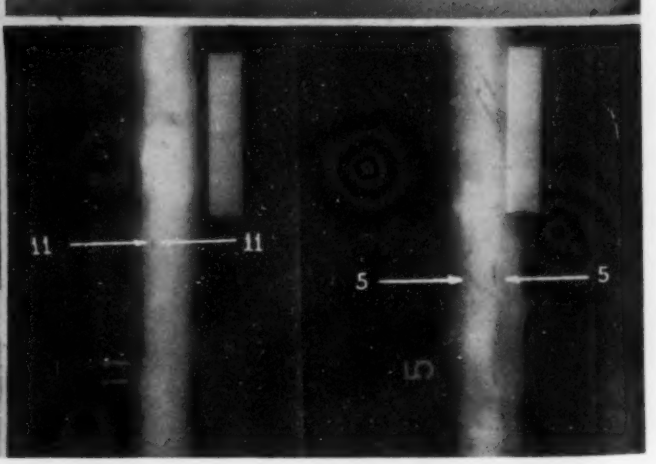


Fig. 13

rôle of a control instrument that the X-ray has proved to be of immeasurable value. Defects in welds may be picked out and judged with remarkable accuracy after some little experience is gained. Too, it is fairly simple to correlate the findings of the X-ray with improper shop practices to the end that the latter may be eliminated. The X-ray machine stands as a constant, vigilant guard standing over each and every welder. From time to time it is used for checking the quality of his deposit. In its use as a random investigator, it tends to keep the welding operators keyed to a high point of welding efficiency. Strangely enough, it is learned that the rules and regulations that have to be established for the proper manipulation of the arc for X-ray perfect welding are quite simple. Because of this, it costs no more to make an X-ray perfect weld than it does to make one of lesser quality. The natural tendency, therefore, is to train each and every operator to a high point of X-ray efficiency, which in turn maintains an excellent quality standard throughout the entire welding shop.

In our early days of this type of inspection, many test plates were radiographed. Figure 6 shows this operation. The X-ray operator has his test plate set on a table which carries a grooved slot for the cassette. Figure 8 is a close-up of that setup. In this picture may be seen the lead numbers used to represent the date, the serial number of the picture and the penetrameters. You will notice that lead is used rather freely over the ends of the seams to prevent fogging of the edges of the film where the radiation is not impeded by the steel plate. The schematic arrangement for the X-raying of a test plate is shown in Fig. 9, where the relative positions of welded seams, film and cassette may be observed.

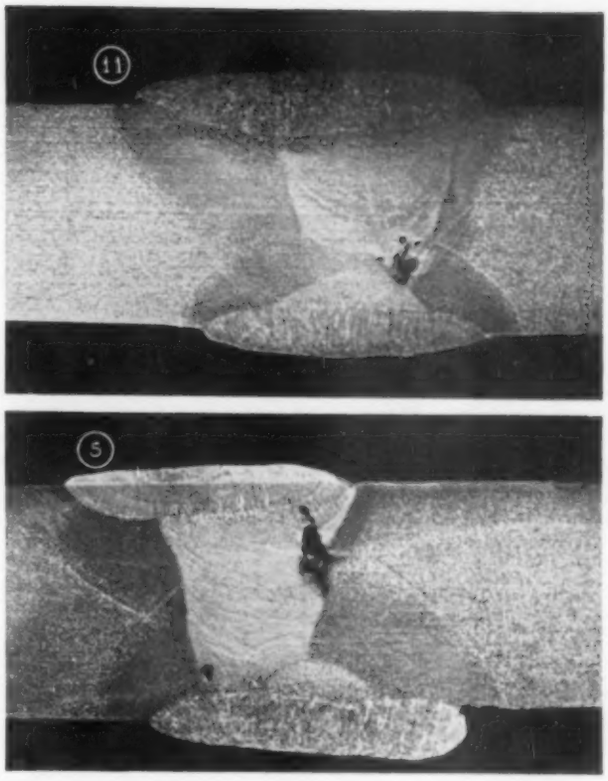


Fig. 14—Macrographs of Weld Containing Slag Inclusions

Fig. 15—Slag Included at Side of Weld

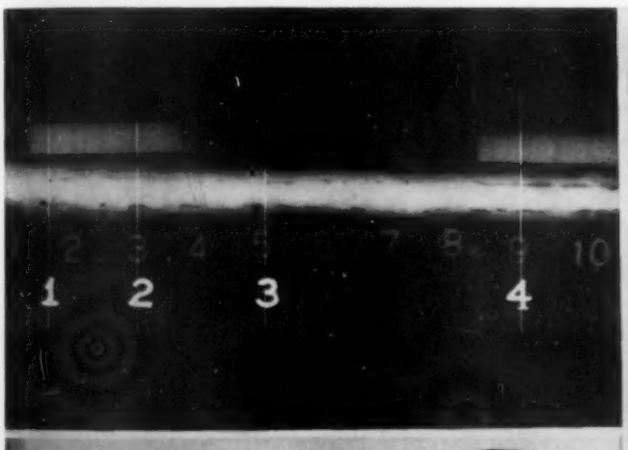


Fig. 16—Macrographs Corresponding to Exographs of Fig. 15

Fig. 17—Exograph of Good Weld (Top) and Poor Weld (Bottom)

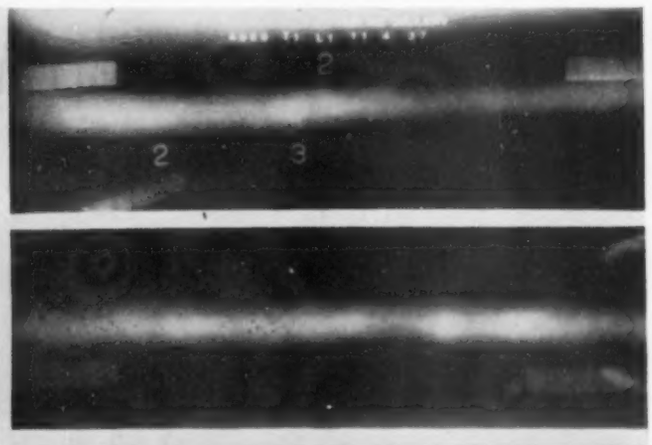


Fig. 18—Exograph Showing Slag Inclusions and Undercut

Figure 10 shows a piece of film being placed on the inside of the cassette with the white portion of the cassette being the identifying screens. These screens are made of calcium tungstate, which changes the X-radiation to fluorescent light. This light registers on the film and takes the picture just as daylight is used to take a snapshot. The intensifying screens reduce the exposure time necessary to make an impression on the film by some sixteen times. No doubt, X-ray examination would be economically unsound if it were not for the intensifying screens and the part they play.

Now, let us turn our attention to some of the commonly found faults in X-rays so that we may interpret the type of difficulties with which we are confronted. Figure 11 represents the welded seam in a pressure vessel that was designed to operate at 1000 pounds per square inch working pressure. This gave every indication of not being chipped and the macrograph which constitutes Fig. 12 substantiates this belief. This type of welding results in a stress-concentration in the unwelded portion. As far as external appearances are concerned, it is impossible to locate welds of this type. If it were not for the availability of radiographic means of detection, welds of this nature might be more prevalent than they are today.

Figures 13 and 14 represent radiographs and macrographs, respectively, of welds that contain slag inclusions. Here an effort is made to correlate the seriousness of these defects as they are picked up by the X-rays. Although we would throw up our hands in horror at seeing radiographs indicative of welds of such low quality as those shown in Fig. 13, Fig. 14 reveals the size of the defects discovered by radiograph. Some people might say that these small defects were not very serious, but fortunately, routine production today far excells the quality of pictures shown in Fig. 13.

In a welding groove, an inexperienced operator is apt to undercut the side walls. This, in itself, is not serious were it not for the fact that the subsequent welding bead usually traps slag in these undercut locations. Figure 15 shows the X-ray, indicating this type of trouble.

Figure 16 is a macrograph showing the actual defects found at the four locations. True, they are not serious but they do indicate undercuts along the sidewalls, resulting from improper welding and cleaning operations.

The next slide, Fig. 17, shows two welds, one of them being very good and the other containing innumerable porosities. The first picture would be considered very good, and the second picture would necessitate the removal of the welded seam and a reweld.

Figure 18 points out two types of weld difficulties. One of them shows the location of slag, which must be removed, in the welding groove, and the other shows the presence of undercut along the overlay beads. These could be removed by a visual examination, of course.

I hope by this brief discussion of present radiographic inspection that I have given you an insight into the types of defects found by this examination and the possibilities of improved work as the result of an intelligent use of the equipment. A further indication of improvement in work might be gained from the fact that our routine welding on vessels not subject to radiographic examination exceeds the best welding level attained prior to the acquisition of an X-ray machine.

TENTATIVE FRENCH SPECIFICATIONS

for Testing the Weldability (Gas and Spot Welding) of Steels for Aircraft Construction*

OBJECT

BY WELDABILITY we generally mean both facility of execution and the properties of welds made in sheet and tubing under assigned conditions. Aside from the fusibility test, only mechanical tests appear in the present specifications. Macro- and microscopic examination cannot be required of materials whose composition is not specified. The tests on gas welding have been designed: (1) to study base metal, not filler metal; hence fracture is forced to occur outside the weld, and (2) to adapt the test to practical conditions, so as not to reject a chromium-molybdenum steel on the basis, for example, of a bend test that does not simulate welding or service conditions.

It is not ordinarily practicable to produce flush gas welds in sheets 0.03–0.06 inch thick, for example. The dimensions of the reinforcement on the bend specimen were selected to insure results independent of sheet thickness. Tests on the tensile specimen have shown, contrary to results on other types of specimens, that fracture occurs, not in the fillets, but in the gage length between the fillet and the weld. If flush specimens are used, fracture may occur in the weld, if it is porous. Since porosity is largely a function of the welder and not of the base metal, reinforced welds are adopted in these specifications. Tests have demonstrated that for the thicknesses of importance in aircraft construction, the shape of the specimen is more important than the presence of reinforcement, provided the steel is of good weldability. The effect of change in the shape of the reinforcement is masked by heat effect.

The elongation is not uniformly distributed in the tension test and is not measured. If the elongation is measured, the shape of the bead must be stated, for it determines the location of fracture, which ought to be recorded for every specimen. Within the limits permitted in the specification, the reinforcement has no appreciable effect on results.

In the bend test, variations in reinforcement within permissible limits may change the bend angle 10° at least. The ratio of rigidities of specimens with and without reinforcement tends to produce low bend angles for thin sheets and to cause failure in the weld in thick sheets. There was only one possible adaptation of the

* Abstract of "Projet de Spécifications relatives aux essais de soudabilité des aciers pour les constructions aéronautiques," published in Revue de la Soudure Autogène, 31, No. 301, 654-660, April 1939. The last date for comments on the specifications, which were drawn up by the French Committee on Welding Standards, was May 15, 1939. Abstracted by Dr. G. E. Claussen.

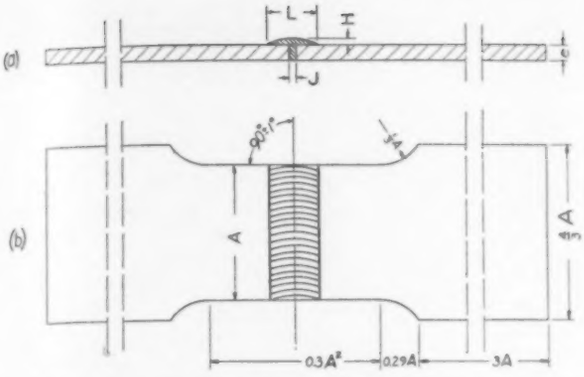


Fig. 1—(*a*) Dimensions of the Gas Welds on Tubes and Sheets Up to 0.16 Inch Thick

$$L\begin{cases}\text{minimum} = 2.5e + 0.10 \text{ inch.}\\ \text{maximum} = 4.25e + 0.12 \text{ inch.}\end{cases}$$

$$H\begin{cases}\text{minimum} = 0.125e + 0.04 \text{ inch.}\\ \text{maximum} = 0.25e + 0.06 \text{ inch.}\end{cases}$$

$$J\begin{cases}\text{minimum} = e/20 + 0.02 \text{ inch.}\\ \text{maximum} = e/10 + 0.04 \text{ inch.}\end{cases}$$

(*b*) Dimensions of the Gas-Welded Specimens for Tensile Tests

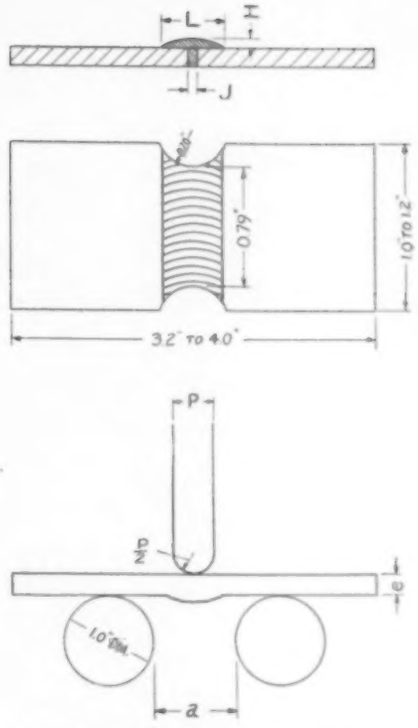


Fig. 2—Bend Test Specimen for Gas Welds

$H = 0.37e + 0.04 = 0.004$ inch.
$L = 1.87e + 0.20 = 0.02$ inch.
$J = e/10 + 0.04 = 0.004$ inch.

Thickness, Inch	Thickness of Plunger, Inch: Tensile Strength Less Than 60,000 Lb./In.²	Tensile Strength Over 60,000 Lb./In.²
0.032–0.039	2e	3e
0.059–0.079	2.5e	3.5e
0.10–0.12	3e	4e
0.14–0.16	3.5e	4.5e

Speed of Testing, inch/sec. = 0.04 for sheet having a tensile strength less than 60,000 lb./in.²
Speed of Testing, inch/sec. = 0.02 for sheet having a tensile strength over 60,000 lb./in.²

$$a = P + 2e + J$$

bend test, namely: not to concentrate maximum deformation in the least favorable zone. Consequently, tests were made with a large number of plungers of different thicknesses. The plunger that was selected for the specifications was that which did not disqualify sheets known to afford good service results. It is not surprising, therefore, that the width of the weld is slightly greater than the developed arc of the plunger for thin sheets, and smaller for thick sheets. The total elongation of the zones next to the weld, which are the zones of interest, is 15 to 20% in all thicknesses. The specimen is notched in order to facilitate the localization of the bend at the weld.

WELDABILITY TESTS FOR GAS WELDING

As-received and annealed tubes or sheets are used to prepare specimens for fusibility, tension, bend and fatigue tests; the results for the last three tests being compared with unwelded specimens. The conditions of welding are governed by the steel itself.

Fusibility Test. A filed surface of steel free from oxide or grease is brought to fusion under a stationary and properly adjusted oxyacetylene flame. The liquid metal must remain quiet without bubbling, evolution of gas or formation of slag.

Tension Test, Fig. 1. For sheets the weld is longer than the maximum width of the specimen. Two welds are made parallel to the direction of rolling; two welds are made transverse. The specimens are cut so that the two ends of the weld are not included. The results are quoted as the ratio of tensile strengths of welded to unwelded specimens. The location of fracture is recorded: in the weld, at the edge of the weld or outside the weld.

Bend Test, Fig. 2. The reinforcement on the reverse side of the weld is removed as far as possible without injuring the sheets. The specimen is placed on two rollers 1.0 inch diameter (±0.04 inch). The supplement of the angle between the cracked sheets is the bend angle. The location of the crack is recorded, or, should none occur, the final angle of bend, which is always less than 180°. The results are quoted as the ratio of bend angles for welded and unwelded specimens.

Fatigue Test on Tubes, Fig. 3. A rotating bend machine with fiber-lined grips is used. The distance between supports is 14.4 inches; the distance between the two loads is 6.1 inches. The results are quoted as the ratio of fatigue strength for welded and unwelded specimens.

Fatigue Test on Sheets, Fig. 4. The weld is made perpendicular to the direction of rolling, and is tested in alternating tension and compression. The results are quoted as the ratio of fatigue strength for welded and unwelded specimens.

The following factors are recorded in all tests: chemical composition (C, Mn, Si, S, P, Cr, Ni, Mo) of base metal and filler rod, type (acetylene or hydrogen) and purity of gases, gas consumption per hr. per unit thickness of steel, flame adjustment, preparation of edges to be welded, composition and form of flux, if any, position

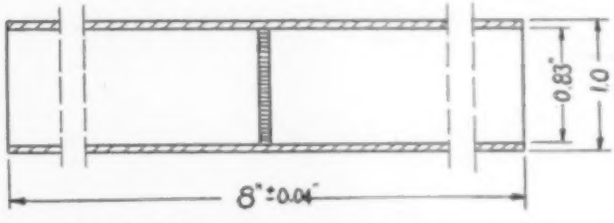


Fig. 3—Gas-Welded Specimens for Fatigue Tests of Tubes. After Being Welded the Tube Must Be Straight to Within One-half the Wall Thickness

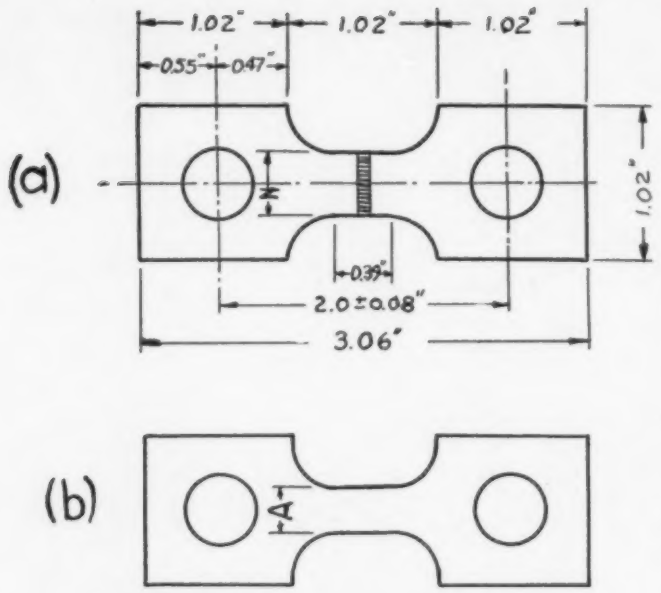


Fig. 4—(a) Gas-Welded Sheet Specimen for Fatigue Test

Diameter of holes = ½ inch.
Radius of fillets = 0.32 inch. $N = 0.394 \pm 0.004$ inch.

(b) Unwelded Sheet Specimen for Fatigue Test

Edges without tolerance to ±0.012 inch.
Dimensions (inches) of Unwelded Fatigue Specimen

Sheet Thickness, Inch	<0.079	0.079 to 0.124
A	0.32 ± 0.04	0.20 ± 0.04

of welding (vertical, left or right hand, two-torch vertical, etc.), mechanical test results, and microstructure and macrostructures of base metal, weld, and heat-affected zone.

WELDABILITY TESTS FOR SPOT WELDING

The tests are to be used to determine the suitability of sheets for spot welding. Although composition is not specified, it has not been possible to exclude macrographic tests. In gas welding the time of welding, while relatively long, is only a secondary factor because it

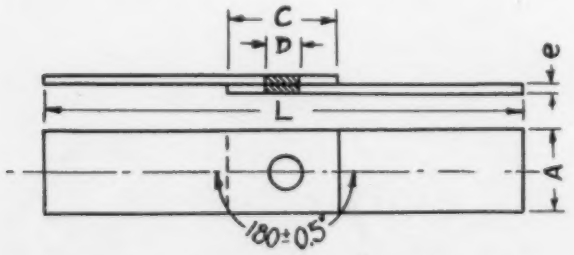


Fig. 5—Specimen for Determining the Strength of the Spot

Specimen 1. Shear in Spot

Sheet Thickness, Inch	Width of Specimen, Inch A	Length of Overlap, Inch C	Distance Between Grips, Inch	Length Engaged by Grip, Inch
Less than 0.06	$\pi D^2/4e$	$3.5D \pm 0.5D$	$15D$	$3A$
Over 0.06	$(\pi D^2/4e) + D$	$3.5D \pm 0.5D$	$15D$	$3A$

D = apparent diameter of spot.

Specimen 2. Tension at Edge of Spot

Width of specimen $A' = R/te$, where R = load at failure of specimen 1 in kg. and t = tensile strength of unwelded steel in kg./mm.²
Length of overlap = $3.5D \pm 0.5D$.
Length between grips = $0.6A'$.
Length engaged by grips = $3A'$.

Fig. 6—Specimen to Determine the Strength of the Metal in the Spot Where Weakening Occurs Due to Welding

Width of specimen $A' = R/te$, where e = thickness of each sheet, mm., t = tensile strength of unwelded steel, kg./mm.², and R = load at failure of specimen 1, Fig. 5.
Length between grips = $0.3A'$.
Length of specimen engaged by each grip = $3A'$.

varies within small limits. In spot welding, on the contrary, the time of welding is a vital factor in view of the large variations that may occur. Since it has become possible to spot-weld alloys that are not in physico-chemical or structural equilibrium, it is essential to exercise control that is specially adapted to these products.

Mechanical properties are not always affected to a detectable extent to determine whether the structure has been made subject to corrosion. The macrographic test then becomes a test of weldability. The conditions for spot welding are determined by specialists of the Committee on the Application of Welding to Aircraft Construction.

Tension Test: Different specimens are used to produce failure by (1) shear in the spot or around it through the

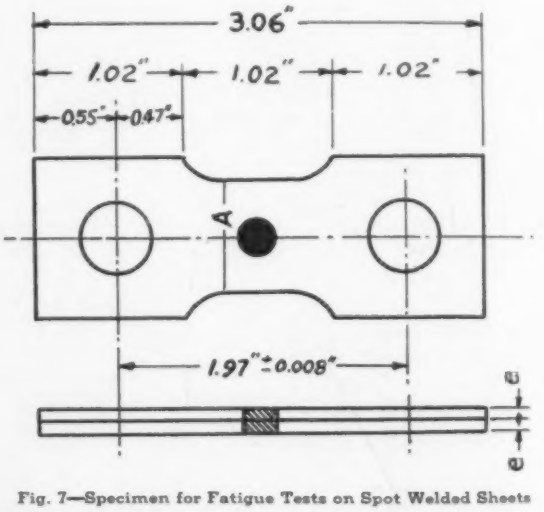


Fig. 7—Specimen for Fatigue Tests on Spot Welded Sheets

Edges without tolerance are machined to ±0.012 inch of stated dimension.
Diameter of holes for grips = ½ inch.
Radius of fillets = 0.32 inch.

thickness, Fig. 5; (2) tension at the edge of the spot, if the properties of the metal in this zone have been injured, Fig. 5; (3) tension in the spot if there has been a decrease in strength in the spot, Fig. 6.

The specimens are welded individually in as-received sheets, the cross section of which is the same as the apparent area of the spot. Specimens intended for determination of tension of the edge or tension in the spot are subsequently reduced to the dimensions shown beneath Figs. 5 and 6. The conditions of welding (current, time, pressure, surface preparation, etc.) shall be identical with those ordinarily used.

The following observations are recorded:

Tensile strength of unwelded metal
Total load on spot (specimen 1), R kg.
Total load at edge of spot (specimen 2), R′ kg.
Half load of specimen 3, R″ kg.
Ratio: R′/R
Ratio: R″/R

FATIGUE TESTS

The specimens consist of two sheets with a single weld, Fig. 7, and are welded individually. At the moment of welding the width of each sheet is the same as the width of the heads of the specimen in Fig. 7. After being welded the specimen is machined to the size specified in Fig. 7. The width of the specimen is the same as that of the tensile specimens 2 and 3. The specimens are tested in alternating tension and compression, or in repeated tension if there is insufficient rigidity. The results are quoted as the ratio of fatigue strength of welded and unwelded specimens.

Macrographic Test: A macro-etched specimen of unwelded metal and two macro-etched specimens of untreated welds, Fig. 5, prepared in such a way that recrystallization due to welding and intergranular precipitation, if any, of a constituent having any effect on corrosion are revealed.

The following factors are recorded in all tests: chemical composition (C, Mn, Si, S, P, Cr, Ni, Mo), duration of welding, current, initial pressure, pressure during welding, type and diameter of electrodes, surface preparation, mechanical properties, and macrographic and micrographic characteristics of unwelded steel, weld and heat-affected zone.

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Welding Society ACTIVITIES—Related Events

E. M. T. RYDER HONORED

Mr. E. M. T. Ryder, Way Engineer of the Third Avenue Railway System, and for many years an active member of the Society has recently received three new honors.

On March 21, 1939, Mr. Ryder was elected Honorary Member of the Connecticut Society of Civil Engineers.

On April 21st, Mr. Ryder was reelected President of the Yale Engineering Assn., of which organization he is a Charter Member. Mr. Ryder acted as Toastmaster at the 25th Anniversary Dinner Meeting at the New York Yale Club on April 21st of that association. As Chairman of the A. W. S. By-Laws Committee, probably the members of the Society will not recognize Mr. Ryder as a songwriter. The program of the 25th Anniversary Dinner Meeting of the Yale Engineering Association carries two songs composed by Mr. Ryder.

On May 1st, Mr. Ryder was initiated in the Connecticut Alpha Chapter at Yale University by the honorary engineering society Tau Beta Pi.

Mr. Ryder also serves as one of the representatives of the American Society of Civil Engineers on Engineering Foundation for the period October 1938 to October 1940. In this latter capacity, Mr. Ryder comes in intimate contact with the research work of the AMERICAN WELDING SOCIETY.

BATTELLE MEMORIAL INSTITUTE

Contracts have been let by Battelle Memorial Institute, Columbus, Ohio, for the construction of a new research laboratory to take care of the expanding volume of industrial research, according to Clyde E. Williams, director. American industrialists are becoming increasingly research-minded, he said, and predicted that the nation's facilities for research will have to be greatly expanded in the immediate future.

This is the second time in the short history of the Institute that space requirements have led to new construction. Less than two years ago a four-story building housing an experimental foundry and ore-dressing and coal preparation laboratories was completed and put into service. The main building itself was occupied and work began in the latter part of 1929. The staff now numbers about 180.

Battelle was established and endowed by the wills of Gordon Battelle and his mother, Annie Norton Battelle, of Columbus, to encourage and conduct industrial research. It carries on fundamental and applied research in ferrous and nonferrous metallurgy, ceramics, physics, organic and inorganic chemistry, fuels, coal preparation and utilization, ore-dressing and materials concentration. Work is done both with its own funds and for industrial sponsors.

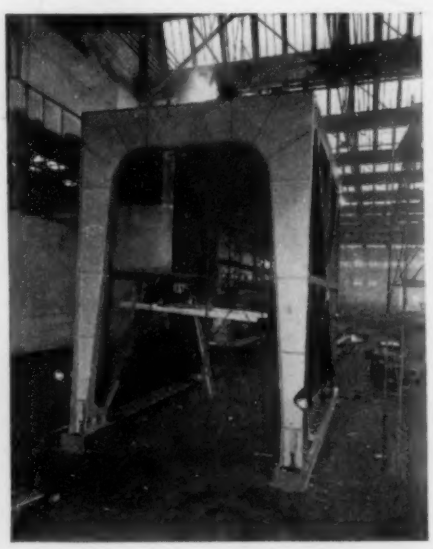
SWISS ACETYLENE SOCIETY

The Annual Meeting of the Swiss Acetylene Society was held June 3rd in Zurich, in conjunction with meetings of the International Technical Committee on Carbide and Welding, and of the Permanent International Commission on Acetylene and Gas Welding. Lectures on oxyacetylene welding were delivered by R. Granjon and Prof. C. F. Keel, and demonstrations of vertical welding were given by R. Meslier and E. Muller at the National Exposition.

OVERHEAD CRANES

The only one of its type, this specially constructed, all-welded gantry crane was recently completed by the Harnischfeger Corporation of Milwaukee. This gantry crane was designed for the specific job of lifting the gates on a large western dam.

The illustrations show this crane in the early stages of construction and as it neared completion. Welding was incorporated into the manufacture of this crane to permit a savings in weight of about 25% and an appreciable increase in strength. Where necessary all units were locally stress relieved.



All-Welded Gantry Crane Nears Completion

Hoists Aid in Spotting of Units to Be Welded

In the course of welding this 20-ton capacity crane which is 22 feet high, Harnischfeger used 1250 lb. of $^1/_4$-inch electrodes, producing welds with a tensile strength of 60,000 lb. per sq. in., elongation of 25 to 35% in 2 inches, and a resistance to impact of 40–60 ft.-lb. As shown in the illustration hoists were used as welding positioners wherever possible to permit easier and more efficient spotting of the units to be welded.

Manufacturers building machines for lifting, lowering and moving loads are adopting rapidly the use of all welded alloy steels because of the increased mobility due to lighter weight and the greater strength any all-welded construction provides.

ARC WELDING PLAYS IMPORTANT PART IN REMOVAL OF RUBBISH

In the accompanying illustration may be seen ten ash removal barges just completed for the Department of Sanitation of the City of New York, built at Mariners Harbor, Staten Island, by Brewer Dry Dock Company, General Contractors.

These barges are all-welded steel hopper type vessels, 150 feet in length, 37 feet in width and 12 feet 9 inches depth to the deck. For additional capacity the barges are fitted with a coaming 5 feet high, so that each one of these barges will replace two of the wooden scows heretofore used for disposal of ashes and rubbish.

These barges were all completed three days ahead of schedule. The layout of the work provided for the building of sections of the double bottom, sections of the wings or double sides, and sections of the rake ends, all of which work was carefully done in jigs, and the result was a greater speed, and a higher grade of exactness was accomplished for the job. The illustration shows the assemblage of eight barges in the

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THE voice of a friend. Reassuring words from father, mother, son or daughter. A hurried call for aid in the night. You cannot set a price on such things as these.

Yet this is true—telephone service is cheap in this country. No other people get so much service, and such good and courteous service, at such low cost.

BELL TELEPHONE SYSTEM

The Bell System cordially invites you to visit its exhibits at the New York World's Fair and the Golden Gate International Exposition, San Francisco

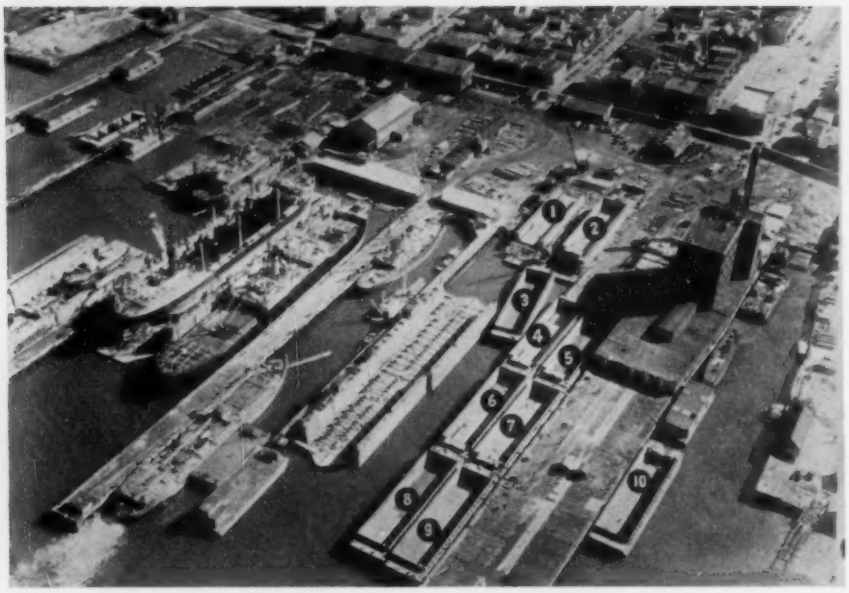

Photo courtesy Hobart Bros. Co., Troy, Ohio

View of Ten Welded Ash Removal Barges

water and two on the ways, ready to be launched, giving an excellent view of the general construction of the barges. These barges are very substantially built of quite heavy shell plating, well framed with angles, and of exceptionally heavy interior or hopper plating to take the effect of the buckets used in unloading. No bucket is used in loading because the way the loading platforms are arranged by the Department of Sanitation in New York City, trucks containing the ashes and rubbish are backed on to the platform directly over the barge, and dumped.

The total thickness of the metal through the head logs and corners, when considering the fender bars which are superimposed on the plating, amounts to $1^1/_2$ in., so that these barges will take a very substantial amount of hard knocks. The bilges and corner rakes are well rounded, making for easy towing.

The house on these barges provides a well-arranged cabin, with one room for galley, equipped with oil range, sink, a spacious locker, table and chair; the sleeping quarters are provided with bed and clothes lockers, and the w. c. conveniences are exceptionally well arranged. The floor of the cabin is given an asbestolith coating, and the roof a coating of cork. The insulation of the walls is Marinite.

Storage tanks of varying capacity are provided for gasoline, fuel oil, lubricating oil and potable water. The electric system is carried through the cabin and generator and pump room and outside of the barge alongside the coaming, so that it is all invisible and well protected.

All in all, the barges are exceptionally well and substantially designed, and it is evident that much careful study has been put into the subject. Construction has been carefully carried out under the supervision of the inspectors of the Department of Sanitation; Messrs. Cox and Stevens, the Naval Architects on this contract; Public Works Administration; and representative of the American Bureau of Shipping, who will class these vessels for the city.

The city will save a substantial sum in rental, each of these barges carrying about double of the scows which have been heretofore used for disposal of ashes and rubbish, and it will also save a substantial sum in towing.

Thirty of these ash removal barges are to be built for the Department of Sanitation of the City of New York by the Brewer Dry Dock Company.

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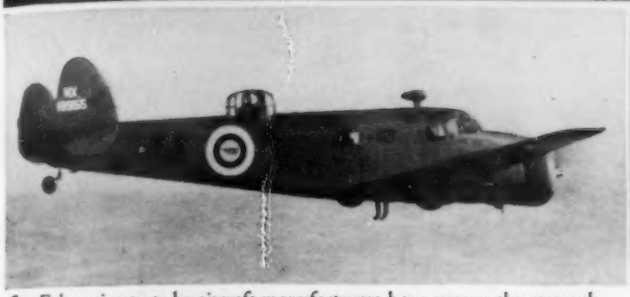
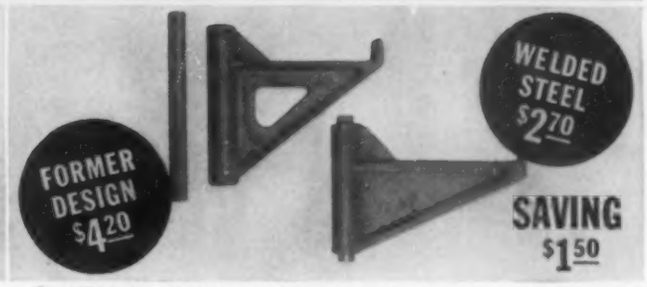
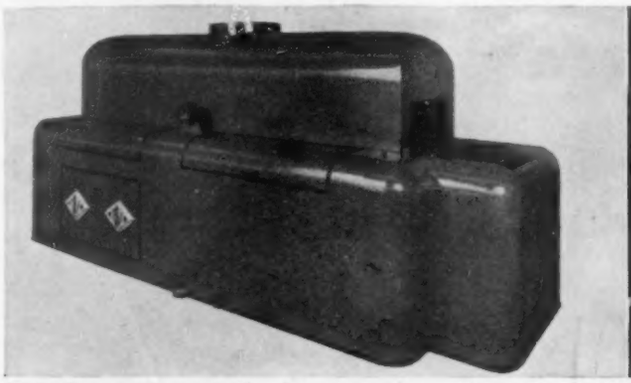
DID YOU KNOW THIS *About Welded Design?*



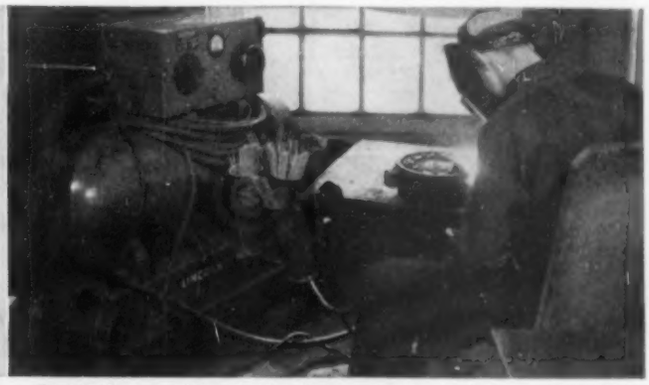
1. Exhaustive tests by aircraft manufacturers have proven the strength-superiority of the shielded arc process for welding critical parts such as landing gears and engine mounts. Inspection of a shielded arc weld shows you how perfect it is. And with proper procedure, it is usually stronger than the parent metal! *Photo courtesy Lockheed Aircraft Corp., Burbank, Calif.*



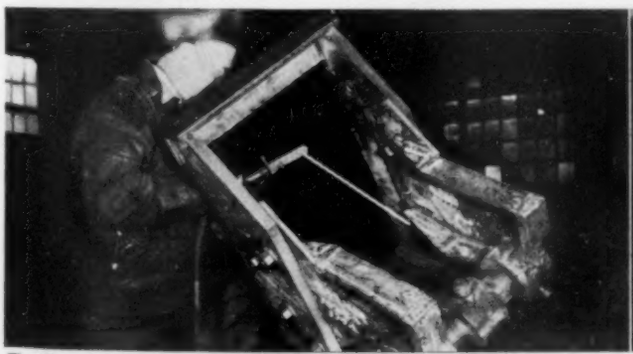
2. Welded steel design cuts costs by reducing the weight of material and by simplifying manufacture. Usually, the larger the part the greater the savings, although many small parts such as the swinging bracket illustrated above can be weld-economized. Try it!
Courtesy Rogers Bros. Corp., Albion, Pa.



3. Products are more saleable when they are streamlined by welded design. Example: The welded steel conveyor washer illustrated above. In this case, welding also has made production more flexible for special designs and has made possible a construction that is permanently leakproof.
Photo courtesy International Conveyor & Washer Corp., Detroit, Mich.



4. Welding simplifies the development of new and improved products. Here is a new type of electric cooking unit—operating by induction rather than resistance. Its construction is made possible by welding. The New *"Shield-Arc"* simplifies welding of its high silicon steel.
Photo courtesy The Griswold Manufacturing Co., Erie, Pa.



5. To minimize costs on heavy machine parts: Form steel plate—hot if necessary—on brakes. Machine before welding. Use heavy fixture and positioning jig, so as to allow high-speed welding with large electrodes in down-hand position. *Photo courtesy Wellman Engineering Co., Cleveland, Ohio*

6. By cutting costs and improving products by means of welding, many engineers and production supervisors have gained recognition in the eyes of the management resulting in advancement and increased earning power. It pays *you* to push changeover to welded design!

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"MERCURY" DONE IN STEEL ADORNS FORD FAIR BUILDING

"Mercury" is now a stainless steel figure, a god of the machine age. Running, head lowered to the wind, draperies flying free, he dominates the tower above the entrance to the Ford Exposition at the New York World's Fair—a symphony of line and motion.

No ancient deity is this masterpiece of shining metal. The work of the eminent young sculptor, Robert Foster, this winged messenger is as symbolic of our modern world as the walls of glass that shimmer beneath him and the spiral, scientifically banked highway around which winds a rainbow stream of cars.

In creating a new kind of "Mercury" as the exterior decorative keynote of the Ford Exposition, Sculptor Foster turned to stainless steel as his natural medium. Thereby, he has designed the first steel figure of its kind and the largest figure of "Mercury" in the world. The principles embodied in its design are patented by Foster.

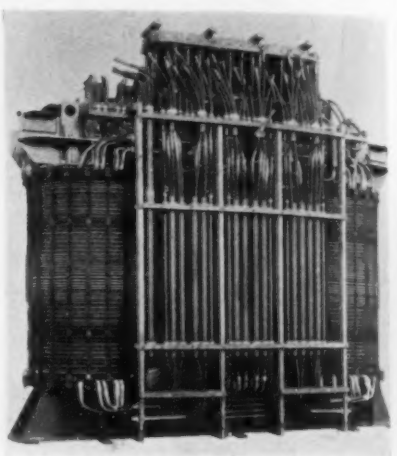
Twenty-five feet high and weighing three tons, "Mercury" is made in three pieces, is of cantilever construction, and has no pillar to support it, but provides its own support by the weight being carried back from the shoulders to the draperies, and thence to the building. In this way, no metal armatures or concealed framework were needed, and "Mercury's" only contact with the building itself is at the end of each of his flowing drapes and at his rear foot.

World's Largest Sculptured Mercury, in Stainless Steel, Takes His Dominating Position on the Ford Fair Building

This unique method of suspension gives much more feeling of flow to the figure, and achieves the sculptor's ideal of a "Mercury" which has both lightness and strength. In this way the flow of the body is repeated and carried back to the building by the flow of the drapery. Formed entirely of bent stainless steel sheets, *electrically welded*, the bent pieces delineate the form as a visitor looks at the edge of the figure, and define the mass as the visitor looks at the side elevation.

SIX MILLION SILVER BRAZED JOINTS

A production record recently released by the General Electric Company tells of a remarkable service they are getting from low temperature brazing alloys in constructing transformers. More than six million copper to copper joints have been made in the last few years and to date there has not been a single field failure. These joints are mainly between taps and coil conductors and between copper bars. Incandescent carbon heating



This 40,000 Kva. Transformer Has More Than 400 Sil-Fos Brazed Joints

HAVE YOU A PRODUCT THAT SHOULD BE DESIGNED FOR WELDING?
Hollup Engineers will help you design or redesign your product for greater strength, less weight and simplicity.
We invite you to submit your welding problems to our design engineers.
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HOLLUP ENGINEERED ARC WELDING
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Welding Wire and Equipment

ROEBLING

the custom-made wire for exacting welders

★ BARE WELDING ELECTRODES

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★ GAS WELDING WIRE

ROEBLING WELDING CABLES:

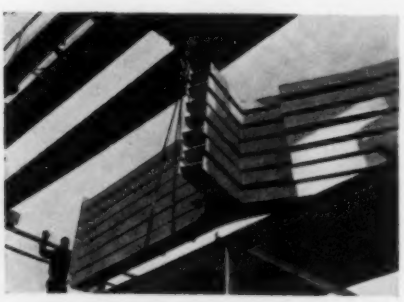
Made in a complete line of rubber and braided types for arc welding purposes.

JOHN A. ROEBLING'S SONS COMPANY, TRENTON, N.J.
Branches in Principal Cities

ONLY A FINE PRODUCT MAY BEAR THE NAME ROEBLING

is used principally in making them and the alloy, which is a silver, copper, phosphorus composition, is preplaced in strip form between the parts joined or, in some joints, is fed in from a rod by hand. Numerous tests have been made to determine the electrical conductivity of this type of joint. Lap joints show less resistance than the copper itself, while butt joints show a very slight amount more resistance. The transformer shown includes more than 400 joints brazed with silver alloys.

TREE FORM COLUMNS



A Lift of Tree-Form Columns Ready for Shipment from The Austin Company's Fabricating Shops to the Side of a New Factory Applying Austin's Special Rigid Frame Sawtooth Design

WELDED TOWER

Photo courtesy American Bridge Co.

The Above Illustration Shows the Welded Polish Tower Under Construction at the New York World's Fair. This Was Rather a Unique Job and the Spiral Corners Presented an Interesting Fabricating Problem

MACHINERY CODE COMMITTEE APPOINTED

The AMERICAN WELDING SOCIETY acting on the recommendation of the Committee on Outline of Work has appointed a committee to revise the A. W. S. Machinery Code. Mr. J. D. Gordon of The Taylor Winfield Corporation is Chairman of the Committee. Other members are: Everett Chapman, C. H. Jennings, W. E. Crawford, J. Kincaid, R. W. Clark, G. F. Jenks, Officer-in-Charge, Specifications Sections, Design Div., U. S. Navy, C. M. Underwood, W. Maddux, R. Diserens, H. J. Stein.

STORAGE TANKS

The AMERICAN WELDING SOCIETY has appointed a committee on Welding Standards for Tanks for the Storage of Liquids Under Pressure Not to Exceed 15 Lb. Per Sq. Inch. The members of the committee are: Chairman, H. O. Hill, Bethlehem Steel Company; H. C. Boardman, Walter Samans, H. A. Sweet, J. O. Jackson, E. W. Fowler and C. W. Obert, Sr.

MOTOR CRUISER STRUTS AND RUDDER

A departure from conventional practice in the construction of motor boat propeller

National

Carbide

DEPENDABLE

EFFICIENT

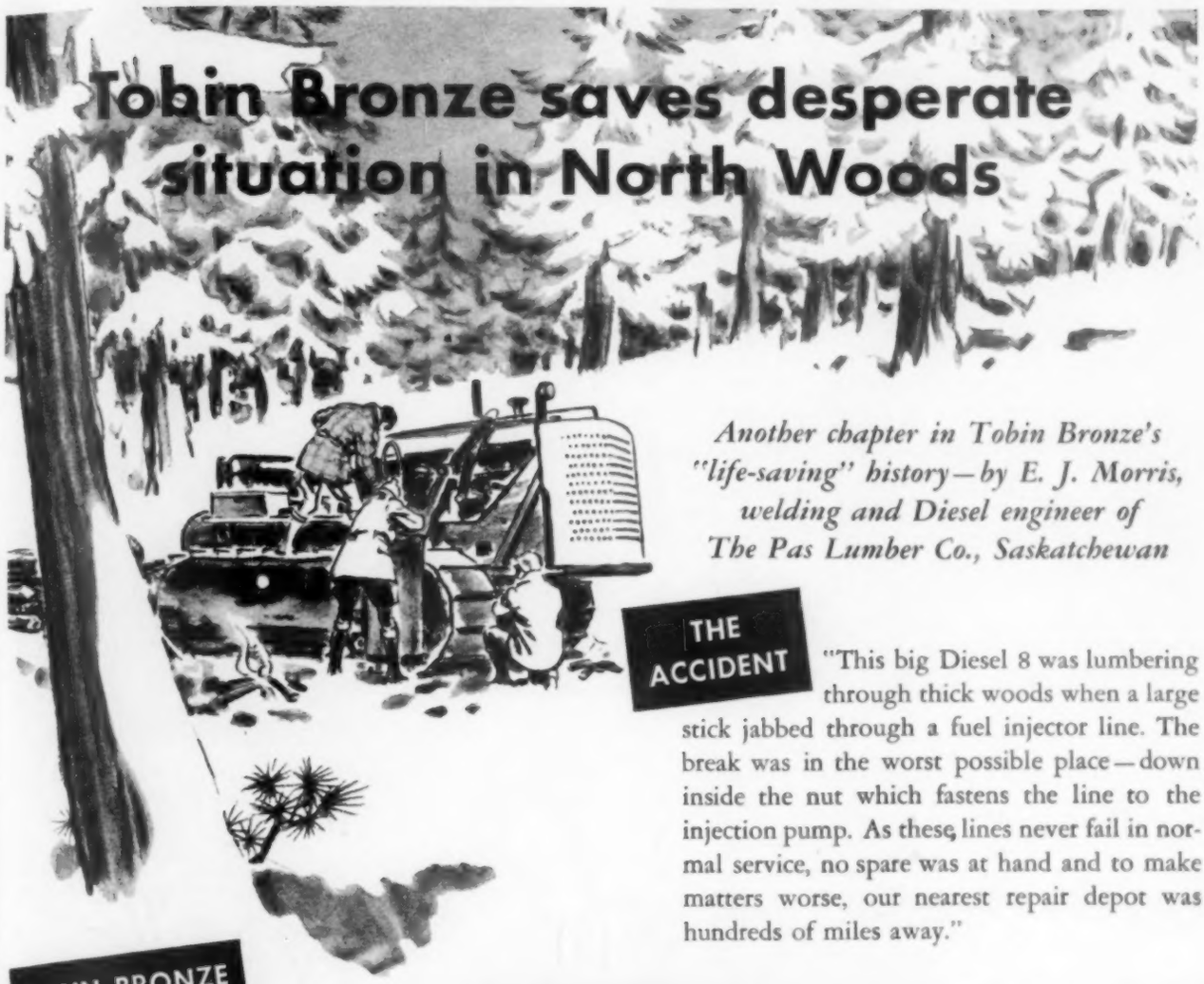
ECONOMICAL

FOR WELDING and CUTTING

Use National Carbide in the Red Drum

Lincoln Building — NATIONAL CARBIDE CORPORATION — New York, N. Y.

Tobin Bronze saves desperate situation in North Woods



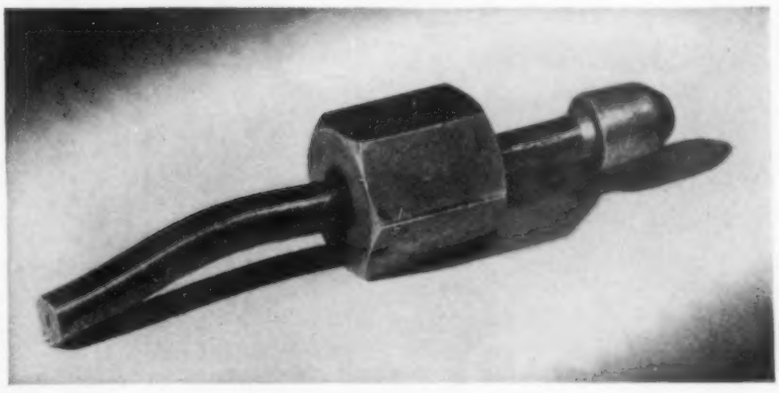
Another chapter in Tobin Bronze's "life-saving" history—by E. J. Morris, welding and Diesel engineer of The Pas Lumber Co., Saskatchewan

THE ACCIDENT

"This big Diesel 8 was lumbering through thick woods when a large stick jabbed through a fuel injector line. The break was in the worst possible place—down inside the nut which fastens the line to the injection pump. As these lines never fail in normal service, no spare was at hand and to make matters worse, our nearest repair depot was hundreds of miles away."

TOBIN BRONZE TO THE RESCUE

"We decided to try repairing the line with Tobin Bronze welding. In making the repair, the parts were ground cone shaped to allow almost complete penetration of bronze; alignment was secured by running a wire through the parts; and the weld made with Tobin Bronze. In about three hours, the machine was back at work and the welded line, which is subjected to pressures of 1800 to 2500 p.s.i., operated perfectly."



This is another instance proving the value of this Anaconda Welding Rod for difficult jobs on copper and copper alloys, steel and iron. Tobin Bronze carries the trade-mark "Tobin Bronze Reg. U. S. Pat. Off." in each rod. Look for this trade-mark and be sure you are getting the genuine. 39132

Visit the Copper & Brass Industry Exhibit in the Metals Building, New York World's Fair—1939.

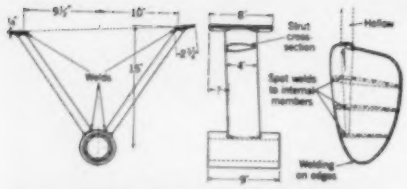
© N.Y.W.F.

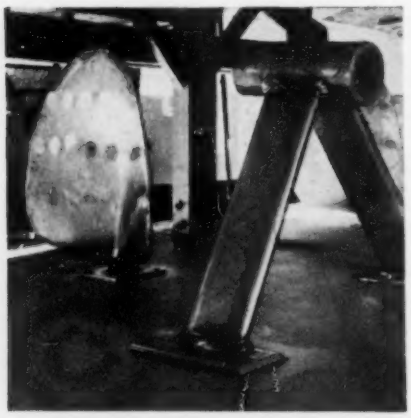
ANACONDA

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • Subsidiary of Anaconda Copper Mining Company





struts, rudder and similar under-water parts, is revealed in a new cruiser recently launched at the Consolidated Ship Building Company's yards in New York.

Casting is the usual method by which such parts ordinarily are produced. In this case, they were fabricated by electric welding Monel strip and plate. Suitability of such construction depends on the mechanical and corrosion resistant properties of the material used.

Two struts are provided for each of the twin Monel shafts—one forward and the other aft. Legs of the struts were made from Monel strip $^{3}/_{16}$ of an inch thick, bent to form one streamlined section, and joined by welding. The legs were then welded to a bearing hub and to a hull fitting of $^{5}/_{16}$ of an inch Monel plate. The bearing hubs, likewise, were fabricated, $^{3}/_{8}$ of an inch plate being used with a butt-welded seam.

Two pieces of Monel sheet, 16 gage, were spot-welded to three internal ribs of Monel strip and welded along the edges to form the rudder. The rudder stock was made of Monel tubing with a $^{1}/_{8}$ of an inch wall thickness, carried through a port also made of Monel tubing. Where the rudder stock joins the rudder, a flat section is welded in the tube. This continues down through the rudder itself and is held in place by the three internal ribs. All these under-water parts were designed and constructed by Youngstown Welding & Engineering Company, Youngstown, Ohio.

THE SMALL JOB SHOP

THE WELDING JOURNAL is anxious to publish in each issue an article of special interest to the welding operator or the job shop owner. It cordially invites the cooperation of everyone to furnish interesting articles of this sort, which the Publications Committee can consider for this purpose.

NICHOLS APPOINTED TECHNICAL ADVISOR

Effective June 1, 1939, National Electric Welding Machines Co. of Bay City, Michigan, has announced the appointment of Leonard E. Nichols, formerly its Chief

Welding Engineer, as Technical Advisor and Sales Engineer for the Detroit District Sales Division, with headquarters in Detroit, Michigan.

* GREATER HARDNESS
* HIGHER CONDUCTIVITY
* LONGER LIFE

* You get them all with MALLORY tips, wheels and dies!

Don't penalize your production with fast-wearing "weak-sister" electrodes. Standardize on the Mallory alloy best suited to your job.

Mallory's revolutionary New Type tip—cold worked by a new process—insures greater uniformity in strength, hardness and conductivity, with consequent longer life. A complete line of standard tips and water-cooled holders in stock for immediate delivery. Save time and money—get more and better welds at less cost. Standardize on Mallory tips and holders.

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A Flux for every metal: Cast Iron Welding Flux No. 1.; Brazing Flux No. 2; Braz-Cast Flux No. 4, for bronze-welding cast iron; "ABC" Aluminum Flux No. 3 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; "Anti-Borax" Tinning Compound No. 11.

Send for Free Samples

ANTI-BORAX COMPOUND COMPANY
Fort Wayne, Indiana

REGO
WELDING AND CUTTING EQUIPMENT
- Welding Torches
- Cutting Torches
- Economizers
- Regulators
- Outfits

FOR PLUS PROFIT SPECIFY REGO
Send for Catalog R-120 — with it you will have all the specifications you need for the buying of highest quality welding and cutting equipment.
The BASTIAN-BLESSING Company
282 E. ONTARIO CHICAGO

WHAT IS RESISTANCE WELDING?

Resistance Welding is a metal fabricating process in which the fusing temperature is generated in the component parts to be welded by a combined application of sufficient electrical current and forging pressure to desired localized areas, without the use of any extraneous materials whatever.

In high production operations, it is by far the most economical assembly method known; it affords the highest quality method of joining parent metals and in some cases, it is the only possible means. It can be utilized on a broad variety of dissimilar metals.

Are you attaining the maximum benefits from resistance welding?

Are there operations in your plant that could best be performed by resistance welding?

Resistance Welder Manufacturers Association

505 Arch Street — Philadelphia, Pa.

MEMBER COMPANIES

Acme Electric Welder Company, Los Angeles
American Electric Fusion Corporation, Chicago
Eisler Engineering Company, Newark, N. J.
Expert Die & Tool Company, Detroit
Federal Machine and Welder Company, Warren
Multi-Hydromatic Welding and Manufacturing Co., Detroit, Mich.
National Electric Welding Machines Co., Bay City
Progressive Welder Company, Detroit
Swift Electric Welder Company, Detroit
Taylor-Hall Welding Corporation, Worcester
Taylor-Winfield Corporation, Warren
Thomson-Gibb Electric Welding Co., Lynn
Welding Machines Mfg. Company, Detroit

ASSOCIATE MEMBER COMPANIES

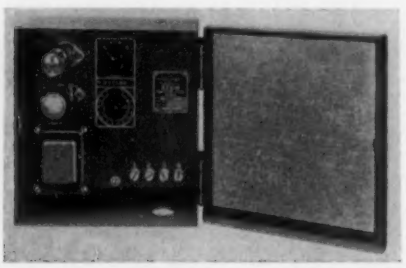
P. R. Mallory and Co., Indianapolis
S-M-S Corporation, Detroit
Electroloy, Inc., New York
Welding Sales and Engineering Co., Detroit

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

E. C. & M. NEOTRON WELD TIMER

For use with spot, butt and projection welding machines, to automatically control the length of time the current is allowed to flow through the pieces being welded, The Electric Controller & Mfg. Company, 2706 E. 79th St., Cleveland, Ohio, announce the E. C. & M. Neotron Weld Timer.



The Neotron Weld Timer operates on the principle of the time required to charge a condenser to a predetermined voltage. When this voltage is reached, the condenser discharges through a neon tube to open the magnetic contactor handling the main power circuit to the welding machine. This timer gives a definite time for each weld. As illustrated, this timer, when used on 60-cycle frequency, gives a selection of time varying from 1/2 to 60 cycles, by operating two small adjusting dials on the front of the panel. The values of time given do not include the time constant for operating the magnetic contactor.

For greater length of time than 60 cycles maximum, a timer with larger condenser is available which will give a time range from 1 to 120 cycles. A still greater time up to 300 cycles can be secured when required.

FOG-GLE CLOTH

To help meet the problem of fogging lenses in goggles, masks, shields and other safety equipment where glass is used, the Industrial Products Company, manufacturers of safety equipment, 800 W. Somerset St., Philadelphia, Pa., have brought out a special cloth chemically treated to retard fogging and steaming.

STANDARD HOSE CONNECTION SPECIFICATIONS

The International Acetylene Association of 30 East 42nd Street, New York, N.Y., has issued a revised Standard Hose Connection Specification, Class A, B, C and D, as adopted at the Annual Meeting of the Association in Houston, on March 9, 1939. Copies may be secured from the International Acetylene Association.

GAS FLUX

A free-flowing flux for gas welding of aluminum and aluminum alloy shapes, has been placed on the market by Park Stewart, 524 Western Ave., Aspinwall, Pa. Known as Flo-Ez-Flux, it is packed in 15-, 5-, 2-, 1- and 1/4-lb. glass containers, such as shown in the illustration. These containers do not corrode, as do metal containers, and they protect their contents at all times from moisture contained in the air, thus assuring an absolutely pure flux which will not cake or harden. The 15-lb. container is equipped with a handle for easy carrying.

Flo-Ez-Flux Is Packed in Non-Corroding, Moisture Proof, Glass Containers Which Preserve Its Useful Life to the Last Grain

GALVANIZING POWDER

The American Solder and Flux Company of Wayne Avenue and Berkley Street, Philadelphia, Pa., have just issued a folder describing Amco Galvanizing Powder. This Powder produces a protective surface that is equal in corrosion resistance to that provided by the hot-dip process. It is used to replace the protective surface of metal products and equipment removed or damaged during assembly operations such as welding, forming, bending, riveting, threading, abrasion and fabrication. Because it forms a surface that is firmly bonded to the original metal it is not to be considered as a coating that will chip and flake off—nor will it have to be done over periodically—it produces a permanent surface. Metals coated with Amco Galvanizing Powder may be bent, buckled or dented without damaging the protective coating. It has successfully withstood the most rigid tests, including the salt spray. Amco Galvanizing Powder is specifically made for repair work, where it is not practical to hot-dip.

STAINLESS STEEL ELECTRODE

The Lincoln Electric Company, Cleveland, Ohio, announces a new arc-welding electrode of the 18–8 type, having 3 1/2% molybdenum.

The new electrode, designated "Stainweld C," was developed to meet a demand for an arc-welding electrode to weld the considerable number of stainless steels on the market which contain approximately 3 1/2% molybdenum. "Stainweld C" provides weld metal of proper physical and chemical properties for welding such steels. A coating is provided on the electrode which prevents oxidation of the weld metal and keeps the analysis of the deposited metal virtually the same as the parent metal. Due to this, welds are of high tensile strength and ductility and

No. 6 FLUXINE (IN POWDER FORM) FOR BRONZE-BONDING
★ CAST IRON AND GRAY IRON WITH BRONZE AND NICKEL ALLOY RODS (NON-GLARING)

No. 6 FLUXINE is the ideal flux for welding motor heads, valve seats, cast iron boiler sections, etc. Does not glare or incandesce, thereby permitting welder clear vision. Flows at low temperature. Requires very low preheating. Produces smooth, strong, non-porous joints at fusion point.

SEND FOR FREE SAMPLE

Manufactured by

KREMBS & COMPANY

Chemists Since 1875

669 West Ohio St. Chicago, Ill.

And Now, a Modern

ELECTRODE

McKAY SHIELDED ARC WELDING Electrodes

The right electrode and the right method for each job are the keys to successful welding. Every modern resource is employed to improve McKay Electrodes and to aid the user. Ask for folder.

The McKay Company
McKay Building
Pittsburgh, Pa.

Proved on thousands of jobs..

PAGE

Hi-Tensile "G"

PAGE Hi-Tensile "G" has proved itself on thousands of jobs of many kinds. It has proved that it produces a tough, ductile weld that shows surprising elongation and is highly resistant to the effects of shock and strain.

Users value Hi-Tensile "G" for its smooth bead, its fast and easy working qualities, its ability to adapt itself to all current values and to the requirements of practically all types of work.

Ask your local Page distributor for complete information on Hi-Tensile "G" and other Page Welding Electrodes. He may be able to offer some helpful suggestions.

BUY ACCO QUALITY *in Page Welding Electrodes, Page Wire Fence, Tru-Lay Preformed Wire Rope, Reading-Pratt & Cady Valves, Campbell Abrasive Cutting Machines, American Chains (Welded & Weldless) and Wright Hoists.*

PAGE STEEL & WIRE DIVISION • MONESSEN, PENNSYLVANIA

See our exhibit, Metals Building, New York World's Fair

AMERICAN CHAIN & CABLE COMPANY, Inc.

AMERICAN CHAIN DIVISION • AMERICAN CABLE DIVISION • ANDREW C. CAMPBELL DIVISION • FORD CHAIN BLOCK DIVISION • HAZARD WIRE ROPE DIVISION • HIGHLAND IRON AND STEEL DIVISION • MANLEY MANUFACTURING DIVISION • OWEN SILENT SPRING COMPANY, INC. • PAGE STEEL AND WIRE DIVISION • READING-PRATT & CADY DIVISION • READING STEEL CASTING DIVISION • WRIGHT MANUFACTURING DIVISION • IN CANADA: DOMINION CHAIN COMPANY, LTD. • IN ENGLAND: BRITISH WIRE PRODUCTS, LTD. • THE PARSONS CHAIN COMPANY, LTD. • *In Business for Your Safety*

possess similar corrosion-resistance qualities to the parent metal.

The physical properties of "Stainweld C" are similar to 18–8 stainless steel.

EYE PROTECTION

The growing popularity of the Jackson visor type of eye protection device is probably accounted for by the willingness of the workmen to wear an eyeshield of this type. On brazing, soldering, spot and flash welding operations and on many types of grinding and chipping, safety officials have found this type of shield more than adequate and, what is almost as important, have not encountered the usual difficulty in persuading the workmen to keep the shields properly in place.

Jackson Electrode Holder Co., Detroit, Mich., announces important improvements in this shield, the Type C-5 having a stiffening metal binding around the edge of the transparent visor. A fiber spark deflector guard protects the opening between visor and forehead without checking ventilation. The visor will not ignite spontaneously, is non-fogging, hot metal rolls from it. It's available in a number of shades. Also furnished in Monel metal mesh.

FLAME DESCALING APPARATUS

Descales Steel and Cleans and Dehydrates Structural Steel and Plate

Illustrated is the Air Reduction Sales Company's new Oxyacetylene Descaling Apparatus recently developed to remove scale and other similar accumulations from iron and steel by rapidly heating such deposits with the multi-flame tips, thereby causing the cracking-off of the scale as a result of the differential expansion between the scale and the base metal. This process removes scale from ingots, billets and slabs to expose seams and defects for inspection prior to scarfing or chipping, from forgings and steel castings prior to machining and steel castings after annealing. Where necessary, the apparatus is mounted on wheeled carriages for ease in travel across steel surfaces (see illustration).

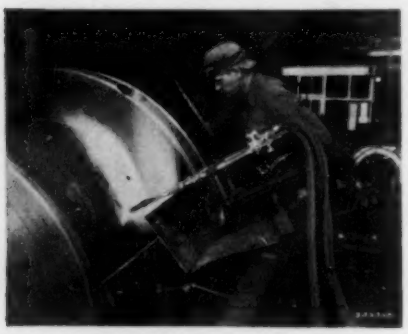


Photo courtesy Westinghouse Elec. & Mfg. Co. and Air Reduction Sales Co.

Carbon Steel Lathe Spindle, 63 Inches in Diameter Being Flame Hardened

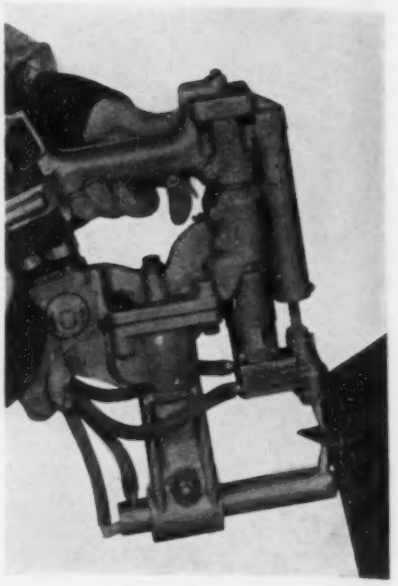
A secondary, but equally important function of the apparatus, is the process of driving out the occluded moisture from within and beneath the surface scale of structural steel and plate by rapidly heating the surface with the high temperature flames, leaving a warmed surface for painting. Immediately after the flame application, the surface is wire-brushed and swept clean of loosened scale particles and dust. Painting follows before recondensation of moisture occurs on the surface. An ideal paint base is thus provided and danger of the further loosening of the tenacious protective mill-scale through weathering is minimized.

LIGHT-WEIGHT WELDING GUN

What is believed to be the lightest weight "pincher" type welding gun ever offered has been announced by Progressive Welder Company, Detroit. Hydraulic in operation, and designed for welding currents up to 50 kva., and welding pressures up to 1000 lb., the new gun is built almost entirely of magnesium.

Weighing but a few pounds, the gun may be easily manipulated with one hand, if desired. Its light weight is designed to reduce operator fatigue, speed up production and improve general welding efficiency, particularly where spot welds are to be made in regular production with one gun in a multiplicity of locations.

As compared with conventional welding guns, an outstanding feature of the new Progressive light-weight gun aside from light weight is the use of the recently perfected sliding contact principle of current transmission. In the new gun, current is transmitted to electrodes directly through the pressure cylinder and piston, the latter being built into the gun.



New Welding Gun with Magnesium Frame for Extreme Lightness Employs Sliding Contact Principle of Current Transmission for Capacities Up to 50 Kva. and Welding Point Pressures to 1000 Lb.

A. C. WELDERS

Marquette announces a 350-ampere model 400 B T.

The 400 B T has a range from 30 to 350 amperes inclusive with a separate tap for each of the 19 heat stages. The amperage is plainly marked beside each tap thus eliminating confusion and speeding up operation. There are no moving parts to wear out. The scientifically designed transformer will operate at full capacity continuously and deliver a strong stable arc at any heat stage. The 400 B T is listed under Reexamination Service of Underwriters' Laboratories Inc.

Another new addition to the Marquette line of A. C. Arc Welders is the model 300 B T, which is similar to model 300 B but is mounted on a new type of truck.

This truck is specially designed for use

SHAWINIGAN CARBIDE

For OXY-ACETYLENE WELDING AND CUTTING OF METALS

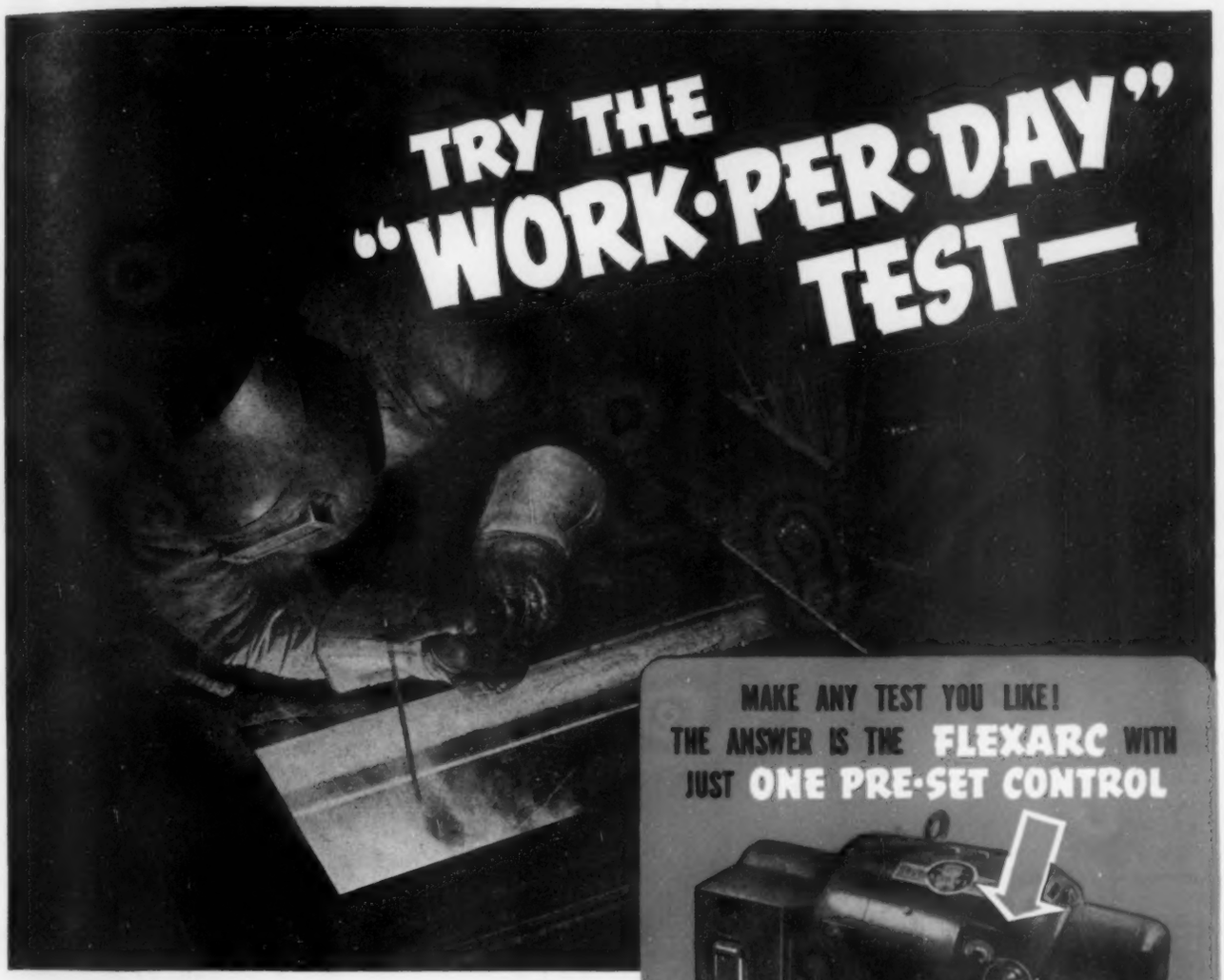
SHAWINIGAN PRODUCTS CORPORATION
EMPIRE STATE BUILDING
NEW YORK, N.Y.

THOMSON

HEADQUARTERS FOR
Manual and Automatic SPOT, SEAM, BUTT, FLASH, PROJECTION, PORTABLE GUN, FABRIC and SPECIAL RESISTANCE WELDING PRODUCTION EQUIPMENT

Write for FLASHES, a monthly magazine of Resistance Welding News and Information. Sent free on request by

THOMSON-GIBB ELECTRIC WELDING CO.
General Offices: 166 PLEASANT ST., LYNN, MASS.



MAKE ANY TEST YOU LIKE!
THE ANSWER IS THE **FLEXARC** WITH
JUST **ONE PRE-SET CONTROL**

Welding claims mean little. What counts is how fast a welder actually lays down metal *on the job* . . . whether it holds a truly stable arc . . . whether it allows the operator to stay on the job and *weld*.

A "work-done-per-day" test with the FlexArc Welder gives a showdown on these facts. ONE PRE-SET CONTROL gives any current needed, *constantly*. Readjustments are eliminated . . . more welding can be done per day because the operator can stay on the job with a faster, constant arc. Test it yourself on this or any other point — but see the FLEXARC in operation before you put money into any welder!

NOW . . . YOU CAN RENT A FLEXARC WELDER!

Mail the coupon . . . Ask for details of the FlexArc rental plan. Rental applies against later purchase in full. Westinghouse Electric & Manufacturing Co., East Pittsburgh Pa. Dept. 7N. J-20813

Westinghouse
Flexarc Welders

LET'S HAVE A SHOWDOWN!

☐ Please arrange a FlexArc demonstration.
☐ Send full details on FlexArc and FlexArc rental plan.

Name.....
Company.....
Address.....
City.....

where quick mobility is important. The handle and pivot on the lead truck make transportation about the shop or factory easy. All four wheels have roller bearings and Alemite zerk fittings. Handle and pivot bearings are Oilite equipped.

PORTABLE SPOT WELDER

The Electric Arc Cutting & Welding Company, Newark, N. J., has brought out a new type of spot welder, as pictured, wherein the welding head, control and automatic switch are in a complete compact unit, arranged to be hung from a trolley or portable crane to handle work that is clamped to a form or jig or not

practical to move for other reasons. This new apparatus is brought out to fulfill the demand for a portable welder where the cable type is not applicable because of cost or insufficient power demand.

The Electric Arc has brought out this hanging model to be as portable as a machine with leads but with a power demand of between 5 and 10 hp.

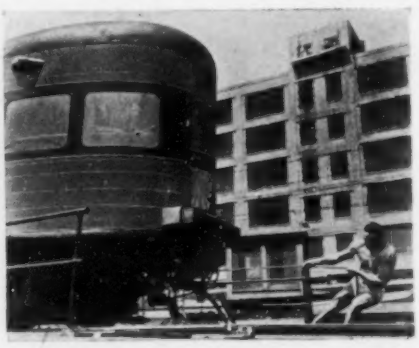
AUTO-SCRAPER

A new welded Model HG, equipped with underbody blade and incorporating many refinements and improvements, was recently announced by The Four Wheel Drive Auto Company, Clintonville, Wisconsin, and Kitchener, Ontario, Canada.

Designed to meet specific needs in the highway field, Model HG was developed primarily for underbody blade service, but, aside from this, serves every purpose as a truck and is ideally suited for snow removal, with either a one-way or "V" type plow.

STRONG MAN REPLACES LOCOMOTIVE

Charles Atlas, the well known strong man, demonstrates how science has overcome the forces of friction by pulling the



observation car of the Pennsylvania Railroad's Broadway Limited more than 100 feet along the tracks. Mr. Atlas (weight 178 lb.) was able to perform this prodigious feat of pulling nearly 1000 times his own weight because the railroad car (weight 145,000 lb.) is equipped with tapered roller bearings. These bearings, which are rapidly replacing the old friction type bearings for railroad use, reduces starting friction as much as 88% in addition to giving the railroads considerable savings in power, fuel consumption and maintenance costs.

NEW ROEBLING MANAGER

The John A. Roebling's Sons Company of Trenton, New Jersey, manufacturers of wire and wire rope, insulated wire and cables and wire cloth and netting, announces the appointment of Mr. Earl N. Graf as manager of its Pittsburgh, Pa. Branch located at 855 West North Avenue.

NATIONAL METAL CONGRESS AND EXPOSITION

Metal and metal products companies appear optimistic about prospects for business during the coming year—if you can believe their record of space reservations for the 1939 National Metal Congress and Exposition. The five day annual Congress will be held this year in Chicago beginning October 23rd.

William H. Eisenman, managing director of the Congress, reports that space for this year's showings of metallurgical progress is 95% reserved; this, with three months remaining before the show. This figure represents a 15% increase in space contracted for 1939 as compared with last year's totals.

New York and vicinity head the reservation list with 35 exhibitors; Chicago area is second with 35 and 18 Ohio companies bring the Buckeye state to third place. Other areas ranking in their order as regards exhibitors are New England, Pittsburgh, Philadelphia, Michigan and Milwaukee, respectively.

The National Metal Congress and Exposition is the annual trade show of the metal field. Manufacturers and fabricators of metals show latest developments at the exhibitions which attract thousands of industrial buyers.

SAVE MONEY... BY WELDING

Jaw Plates, Gyratory and Roll Crushers, Shovel Teeth, Hammers, Tractor Tread Grousers

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Reg. U. S. Pat. Office. U. S. Patents 1,876,738—1,947,167—2,021,945

11 to 13½% Manganese Nickel Steel

WELDING ELECTRODES, WEDGE and APPLICATOR BARS, HOT ROLLED PLATES

STULZ-SICKLES CO. *Sole Producers* 134-142 Lafayette St., Newark, N. J.

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Black and White *Effective May 1938*

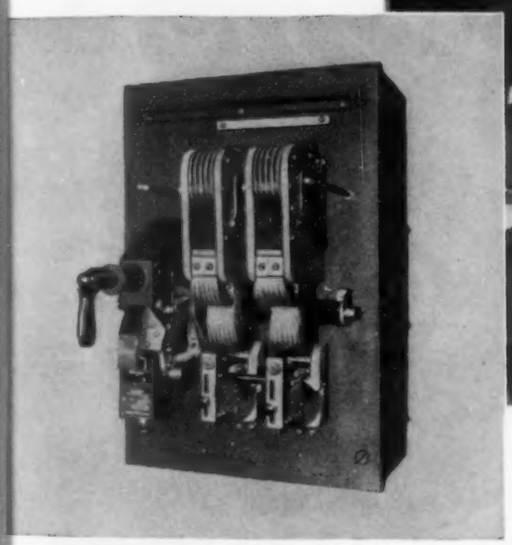
Space	One Insertion	Three Insertions	Six Insertions	Twelve Insertions
*Full Page	$100	$90	$80	$70
Half Page	60	50	45	40
Quarter Page	35	30	27	25
Eighth Page	25	20	17	15
*Inside Preferred	115	105	95	85

*10% Extra for bleed full pages. Color $40 extra per color added.

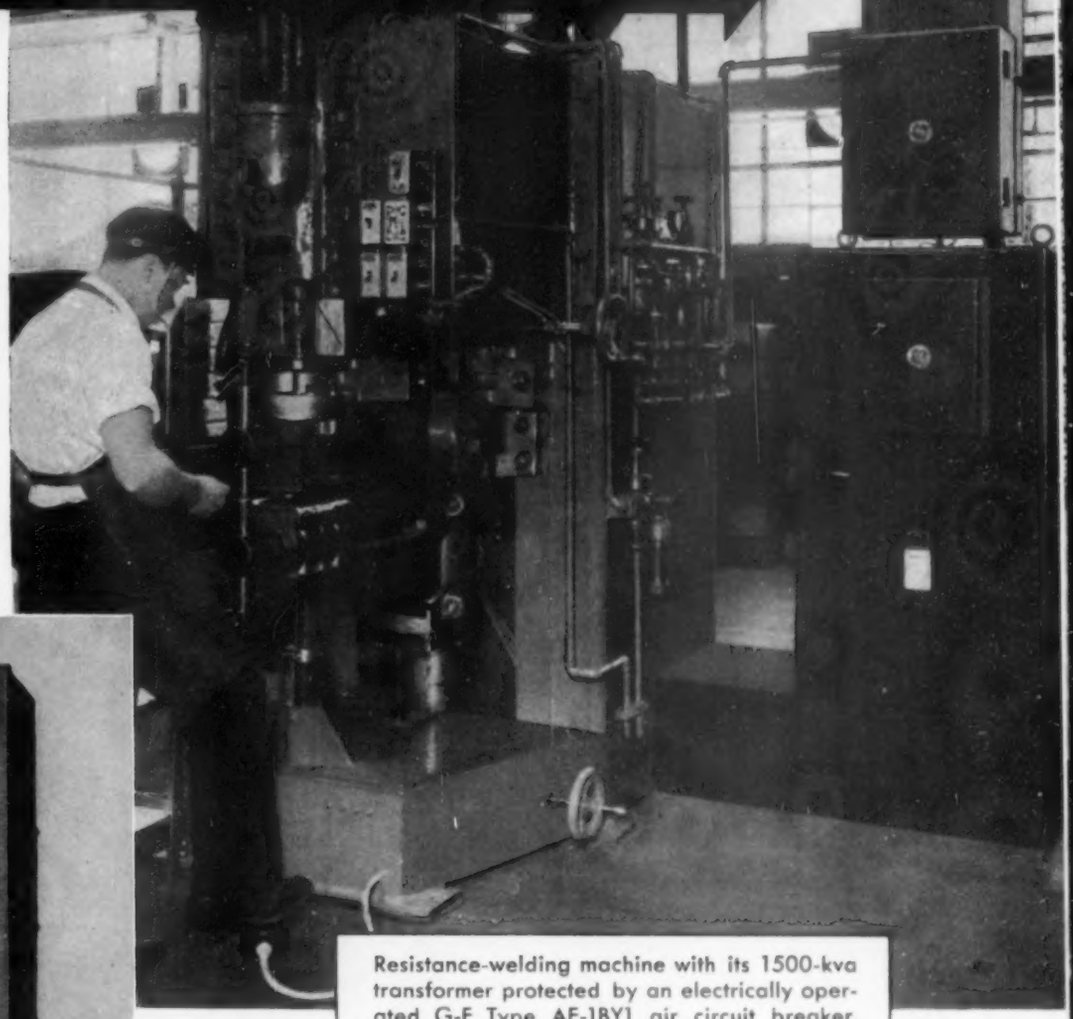
If you check your "IC"

Interrupting capacity

You, too, will want to install G-E air circuit breakers to protect your resistance-welding machines



The manually operated Type AE-1BY1 safety-enclosed air-circuit breaker with enclosing case removed. Note the famous G-E arc quenchers that interrupt dangerous short circuits before your watch can tick twice



Resistance-welding machine with its 1500-kva transformer protected by an electrically operated G-E Type AE-1BY1 air circuit breaker. Controlled by thyratron control

THE severity of a short circuit depends on the capacity of the transformers that supply the current and on the impedance of the feeders. It cannot be determined by the normal load on the circuit. In order to maintain the fairly constant voltage regulation needed for good welding, the feeders must be of low impedance. This tends to increase the severity of short-circuit currents, which presents a serious hazard and gravely endangers property and personnel.

Circuit breakers not only offer the most reliable protection, but they are also able to carry safely those large during-weld currents. Your G-E representative will be glad to help you determine the interrupting capacity needed in order to decide the size of breaker to use for your welding service. Get in touch with the nearest G-E office or write to General Electric Company, Schenectady, N. Y.

SEE THE G-E "HOUSE OF MAGIC"

New York World's Fair — San Francisco Exposition

GENERAL ELECTRIC

890-89

» » » SECTION ACTIVITIES « « «

CHICAGO

The Chicago Section is holding a Golf Tournament on Saturday, July 15th, at Glen Eagles Club, 123rd and Bell Avenue, where Course No. 2 has been reserved for member play starting at 8 o'clock. A wide selection of prizes is in prospect and the charge for the meeting will be $3.00, which includes, lunch, dinner and golf. Full particulars can be obtained by calling the Chicago office, Webster 7134.

The following are the new officers and directors for the Chicago Section who took over their duties following the May meeting:

Chairman—E. A. Balsley, The Link-Belt Co.

Vice-Chairman—L. S. McPhee, Whiting Corporation.

Secretary—M. S. Hendricks, The Welding Engineer.

New Directors for 3 years—Ray Wang, W. M. B. Brady, C. J. Daniels, R. L. Kohlbry.

Directors for 2 years to Fill Vacancy—A. M. Unger and W. R. Hinkle.

Director for 1 year to Fill Vacancy—C. L. Pfeiffer.

The Section also announces that it has moved its offices to 506 South Wabash Avenue, Room 731.

CLEVELAND

The Cleveland Section reports an excellent meeting held in May at Case School on the 10th which was addressed by Mr. L. H. Frost of Electric Controller & Mfg. Company on the subject of Resistance Welding. Mr. Grover A. Hughes of Truscon Steel Company, scheduled to talk at this meeting was unable to attend.

The following officers for the ensuing year have been elected by the Cleveland Section:

Chairman—Fred Plummer
Vice-Chairman—E. T. Scott
Secretary-Treasurer—A. Leslie Pfeil
Committee Chairman:
Educational—L. H. Frost
Meeting—J. C. Wyss
Code—E. R. Benedict
Advisory—A. F. Davis
Symposium—Frank Maine
Publicity—C. T. Elder
Nominating—A. E. Gibson
Refund—E. T. Scott

CONNECTICUT

The Connecticut Section held its annual election on May 16th with the following officers elected:

Chairman—John J. Vreeland
Vice-Chairman—John S. Miller
Secretary—Howard A. Pennington
Treasurer—James R. Mitchell

Mr. Leon C. Bibber, Chief Welding Engineer of the Carnegie-Illinois Steel Co. gave a much appreciated lecture on May 16th at New Haven, on "Impact Testing of Welded Steel," which was illustrated with both motion and still pictures and dealt with full scale tests on welded structures for ships and pressure vessels. His use of high explosives for impact testing of pressure vessels was new and interesting. Another point of especial interest brought out in the discussion was the use of the A. W. S. symbols on drawings which use Mr. Bibber elucidated quite clearly.

DETROIT

A most successful meeting was held by the Detroit Section on June 2nd at the Detroit Leland Hotel. The subject of the meeting was "Brazing with Low Temperature Alloys." Mr. Leo Edelson of Handy and Harman and Mr. J. W. Keyes of Weldit Acetylene Company were the speakers. An actual demonstration of silver brazing was enjoyed by all.

LOS ANGELES

The regular meeting of the Los Angeles Section was held on May 18th. There were 79 members and guests present for the dinner, with about 110 at the meeting, which was held in the Barker Brothers Auditorium.

Mr. Stanley M. Levyn, Acme Electric Welder Company, Huntington Park, gave a very interesting talk on "Resistance Welding Processes and Their Applications."

The second paper on the program was "Resistance Welding in the Aircraft Industry" and was presented by Mr. L. N. Davis, plant Engineer of the Douglas Aircraft Corporation, Santa Monica. His talk was supplemented by Mr. Granville Guy, Supervisor, Spot and Flash Welding Division of the Douglas Aircraft Corp.

The following officers were elected by the Los Angeles Section for the year 1939–1940:

Chairman—C. P. Sander
Vice-Chairman—H. L. Newby
Secretary-Treasurer—J. C. Gowing
Executive Committee for 2 years—John Purcell, Guy Watson and R. W. Reno.
Executive Committee for 1 year—C. W. Roberts, Lloyd Earl and P. D. McElfish.

MILWAUKEE

At the May 26th meeting of the Milwaukee Section, the annual election of officers was held, and the following elected:

Chairman—R. W. Sternke
Vice-Chairman—R. E. Boeck
Secretary-Treasurer—G. F. Meyer
Directors (To serve 2 years)—J. J. Chyle, R. G. Hawley and L. C. Frank.

NEW YORK

The AMERICAN WELDING SOCIETY Day at the New York World's Fair on May 29th, was a memorable occasion for members of the New York Section and their local and out-of-town guests including representatives of sections of Upper New York State, Connecticut, Massachusetts, New Jersey and Pennsylvania.

Among the distinguished guests were Dr. and Mrs. D. S. Jacobus, Commander and Mrs. Edward Ellsberg (who came down from Portsmouth for the occasion), Mr. and Mrs. C. A. McCune, Mr. and Mrs. F. E. Rogers and Mr. P. L. F. Feyling, vice-president of the Boston Section.

Members and guests began arriving at 10:00 A. M., and were sent out in small groups under uniformed guides to visit the various exhibits ending up at the Schaefer Center for lunch.

The afternoon was also devoted to inspections of additional exhibits including a reception and demonstration at the General Electric House of Magic and Steinmetz Hall, thanks to the efforts of Mr. Edmund Vom Steeg, Jr.

Dinner was served at 6:00 P. M., at the picturesque Schaefer Center. There were no speeches and the dinner was delightful in every way, tastily served in a restful atmosphere with a background of tuneful music provided by the Maurice Wolfsie Orchestra.

Nine o'clock found the entire party at the Lagoon of Nations enjoying the brilliant colors and inspiring spectacle of the fountain display to the accompaniment of majestic music. Following this treat, the party broke up into smaller groups to follow their individual tastes for the balance of the evening. It was after midnight before the last group went past the turnstiles homeward bound, all of them well pleased with the program for the day.

The Committee in charge of arrangements for the day consisted of: Messrs. R. W. Boggs, A. F. Keogh, S. S. Scott, E. Vom Steeg, Jr., and Charles Kandel, Chairman.

The Hostesses Committee for the day included: Miss M. M. Kelly, Mrs. A. F. Keogh, Mrs. C. A. McCune, Mrs. S. S. Scott, Mrs. G. V. Slottman and Mrs. Charles Kandel, Chairman.

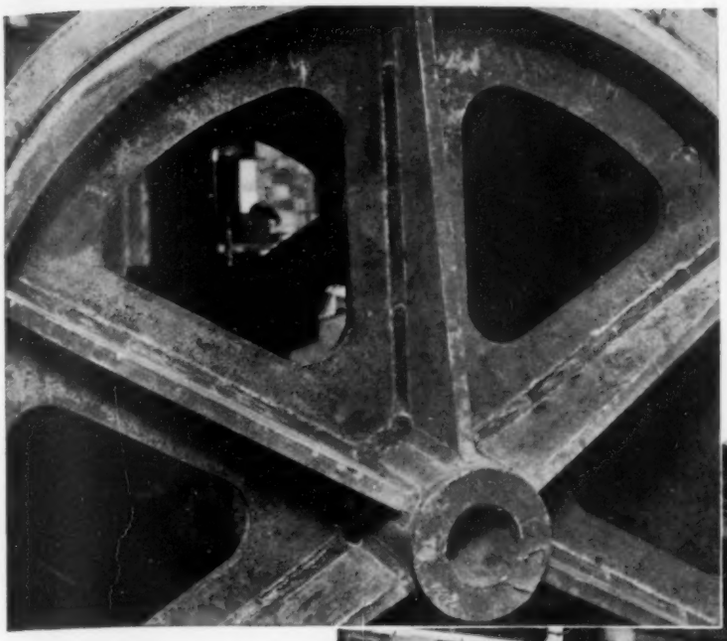
The Committee on arrangements acknowledge with sincere thanks the able assistance rendered by the Executive Committee of the New York Section, the office staff of the National Society under the direction of Miss Kelly, Mr. William Spraragen, editor of the JOURNAL and Mr. E. V. David of the Air Reduction Sales Co.

NORTHWEST

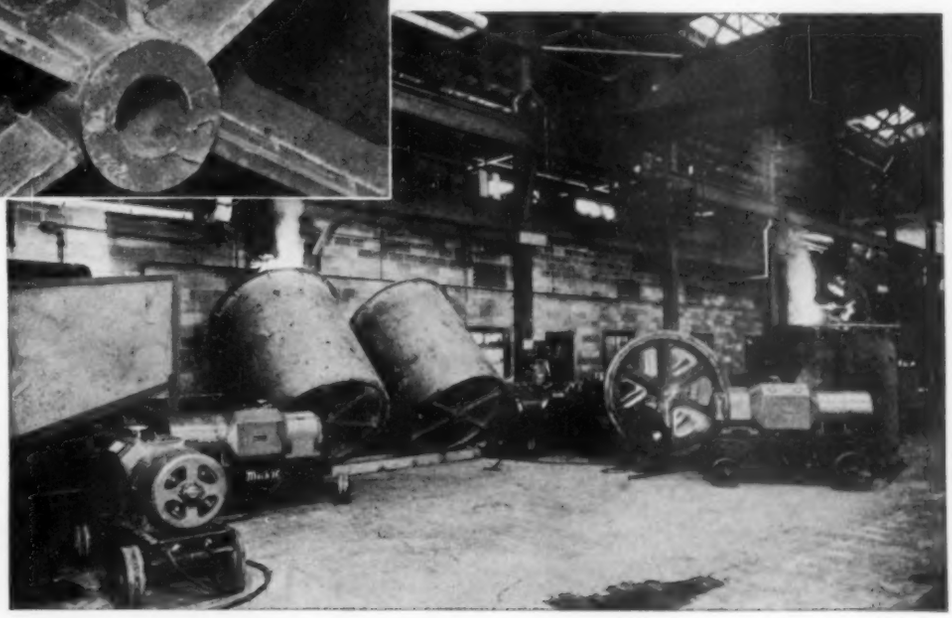
The following officers and members of the Executive Committee were elected at the second Annual Meeting of the Northwest Section, held on May 17th, which was attended by over 100 members and guests.

Chairman—T. J. Warmington
Vice-Chairman—T. P. Hughes
Secretary-Treasurer—Alexis Casell
Executive Committee—C. M. Akins, J. H. Barron, C. E. Comfort, G. W. Irwin, Fred Klass, H. A. Lindeke, W. E. Murphy, John Nelson, R. H. Newton, G. L. Pugh, C. E. Riebeth, R. W. Robinson, V. L. Sage and J. E. Williams.

Mr. E. F. Smith, District Sales Manager, Haynes Stellite Company, was the guest speaker of the evening and presented



ARC STABILITY OF WILSON WELDER ASSURES . . .



WILSON

. . . SOUND, ECONOMICAL FABRICATION OF CRANE DRUMS

Arc stability is the prime essential for efficient low-cost welding with the electric arc. But, of the factors which affect stability, the operator can control only one — arc length. The compensation that must be made for changes in the electrical properties of the arc; and the maintenance of uniformity of arc voltage and current, which is the essence of efficient arc welding, remain the function of the arc welding machine. » » » WILSON engineers have achieved in the WILSON WELDER, the fundamental objective of a high degree of arc stability with a design that is extremely simple, mechanically sound, efficient on both light and heavy loads, and low in power and maintenance cost.

Whatever your welding problem, WILSON engineers will be glad to help you solve it.

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WILSON **ARC WELDERS — *"The machines that make the arc behave"***

a most able discussion on "Flame Hardening," illustrated by motion pictures, and also exhibited a great variety of pieces demonstrating the products manufactured by his company.

PHILADELPHIA

Annual Inspection Trip held by the Philadelphia Section to the Philadelphia Navy Yard on May 17th was a huge success. Very efficient guides took the groups on the inspection trip to witness the welding that is being done by the Navy.

ROCHESTER

Annual meeting of the Rochester Section was held on May 4th in the Todd Union of the University of Rochester. The speaker for the evening was Dr. Wendell F. Hess, of Rensselaer Polytechnic Institute, Divisional Vice-President of the New York & New England Division, A. W. S. Dr. Hess outlined the actions and present situation of the A. W. S. and then gave a very interesting talk on the "Metallurgical Aspects of Welding."

Following Dr. Hess' talk on election of officers for 1939-1940 was held and the following men elected.

Chairman—Edwin Allan
Vice-Chairman—F. L. Peiffer
Secretary—P. W. James
Executive Committee—R. L. Cattnach, W. J. Conley, W. G. Dick, E. L. Hand and W. T. Morgan.

ST. LOUIS

The following officers to serve from June 1, 1939 to June 1, 1940 have been elected by the St. Louis Section.

Chairman—N. F. Moss
Vice-Chairman—A. Schwarz
Secretary-Treasurer—M. E. Meyerson
Directors—A. Allina, Lockwood Hill, J. G. Rosborough, Jr., A. R. Ross, W. N. Schenler and R. G. Thumser.

SAN FRANCISCO

The following officers were nominated and elected at the May 26th meeting held at the Athens Athletic Club in Oakland.

Chairman—T. Rooney
Vice-Chairman—Paul Woods
Secretary—J. G. Bollinger
Treasurer—H. W. Saunders
Directors—C. S. Smith (1 year), E. L. Mathy (2 years), N. F. Ward (3 years).

Following the election of officers, Mr. F. R. Steckle of the Columbia Steel Co. spoke on the subject, "Some Metallurgical Aspects of Welding." Following his very interesting paper an open discussion was held.

Chairman Ward announced that the membership should be thinking and talking about the Welder's Day to be held at the Exposition Grounds on September 24th.

SAN JOAQUIN VALLEY

At the May 26th meeting held in Bakersfield, the following officers and committees were elected:

Chairman—Guy D. Atmore
Vice-Chairman—Joe E. Beebe
Secretary-Treasurer—James Bridges
Executive Committee—Floyd Smith, Harry Hammitt, B. Rintoul and E. R. Harrison.

Membership—R. Rutherford, Chairman, A. J. Ronehausen and I. K. Vandam
Program—H. S. Nix, Chairman, Joe Steen, Joe Beebe and S. L. Howard
Finance—E. R. Harrison, Chairman; C. S. Ogilivie, N. D. Stutzman and Oscar Dunn.

Since this was the last meeting to be held this season, the meeting was given over entirely to entertainment in the form of motion pictures. Members and guests totaling 60 were present and enjoyed the program.

WESTERN NEW YORK

The Western New York Section had their final meeting of the current season May 18th. The speaker of the evening was Mr. Leon C. Bibber, Welding Engineer, with Carnegie-Illinois Steel Corporation. His subject was "Welding Joints—Which Ones to Use—and When and Why." His talk was illustrated with slides.

There were approximately 75 people at this meeting, many from as far as ninety miles from Buffalo. One man came from Syracuse, which is a distance of about 165 miles from Buffalo.

Mr. Bibber's talk was one of the best presented this season and was very enthusiastically received.

Previous to the talk, election results were announced. The following officers and directors were elected for the coming season:

Chairman—J. R. Dawson
Vice-Chairman—W. B. Miller
Secretary—C. S. Freeman
Treasurer—F. O. Howard
Directors for 2 years—Robert Siemer and Thomas H. Speller
Directors for 1 year—E. N. Boswell and Randall Schleich.

WICHITA

Two meetings were held during the month of May by the Wichita Section. The first was held on Thursday, May 18th, at which meeting Professor S. C. Hollister, Dean of College of Engineering at Cornell University, was the main speaker. His subject "Welding in the Construction of Boulder Dam" was well received by the members present. This meeting was preceded by a dinner party for members and the Executive Committee.

The second meeting of the month was held on the 26th at which time the members were guests of the All Steel Products Manufacturing Company. Mr. H. W. Cardwell, President of this concern, gave an informal talk to the group in which he told of his experiences of a recent trip through Europe. This was followed by an inspection trip through the plant.

YOUNGSTOWN

The June meeting of the Youngstown Section was held in the auditorium of Ohio Edison Building on June 6th. The speaker for this meeting was Mr. I. T. Hook, Research Engineer for the American Brass Company, whose subject was "The Welding of Copper Alloys." Mr. Hook delivered a very fine discussion which was followed by an open discussion between members and guests.

This was the last meeting of the Section before recessing for the summer period.

PROSPECTIVE SECTION NEWS

A meeting held in Grand Rapids, Michigan on March 6th was attended by some 52 welding enthusiasts. The main objective of the meeting was to stimulate interest in the AMERICAN WELDING SOCIETY and to try to get a sufficient number of members so that a Western Michigan Section can be organized. Mr. George N. Seiger, President and General Manager of the S-M-S Corporation, spoke on "The Use and Not Abuse of Resistance Welding Electrodes." He gave a very fine talk and it was well received. On May 8th another meeting was held with the same purpose in mind and the evening was devoted to Oxyacetylene Welding and Cutting. The program was sponsored by the Air Reduction Sales Company and a paper was delivered by their Applied Engineering Department's supervisor, Mr. C. D. Welcome. The properties of liquid air were demonstrated and this was of considerable interest to the various people in attendance. There were about 40 present for this talk and demonstration. It is expected that another meeting will be held early in September and by that time it is believed there will be enough members to organize a Section.

EMPLOYMENT SERVICE BULLETIN

SERVICES AVAILABLE

A-314. Welding Engineer and Doctor of Technical Science. Experienced in Electric Arc and Gas Welding, Soldering and Cutting; mechanical and metallurgical testing of welds and rods; layout of welded constructions, sales and maintenance of welding equipment; welding repairs. Desires position as Welding Specialist, Welding Supervisor, etc.

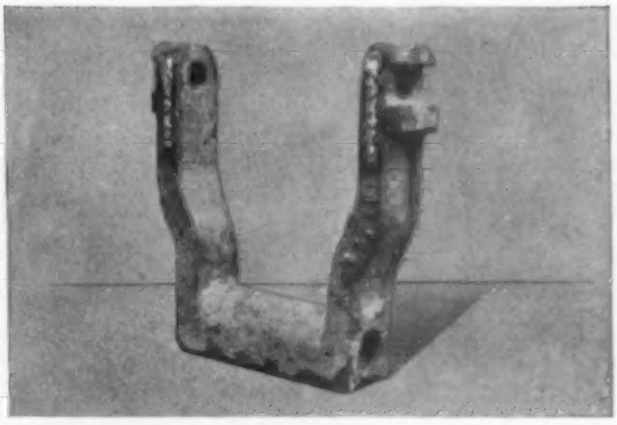
A-315. Graduate engineer desires position. Desire to place one of my graduate students. Has done work in independent arc welding research and graduate research in welding. Received his M.S. degree in June and wants to continue welding research in industry. Graduated with high honors and won two competitive scholarships. 21 years of age and married.

A-316. Combination Welder. Age 26. 6 years' experience. Passed A.B.S. test with Arc and A. S. M. E. Pipe Code test with Acetylene. Also has jobbing ship experience. Prefers field work or shop position with opportunity for advancement. Willing to travel.

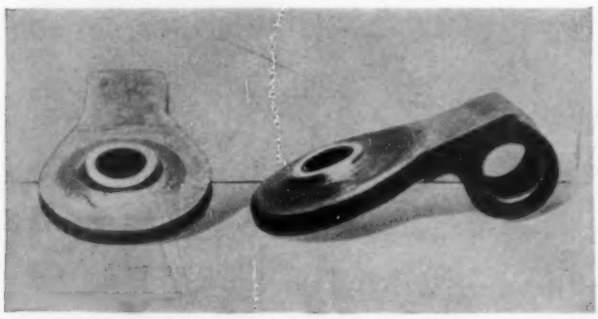
A-311. X-ray Operator thoroughly competent in every phase of metallography. Able to take full charge. Desires suitable connection.

Save money by reducing wear with Haynes Stellite Alloy

CONSTRUCTION—The teeth and side shoes of this skimmer scoop, hard-faced with Haynes Stellite alloy, are in perfect condition after 15 weeks of use. Plain teeth and shoes wore out in 10 weeks.



CEMENT—Hard-facing cement clinker drag-chain links with Haynes Stellite hard-facing rod makes them resist severe abrasion at high temperatures from 3 to 5 times longer than unprotected links.



GLASS—Experience has shown that each of these two drinking-glass neck molds, which have been hard-faced with Haynes Stellite alloy using the oxy-acetylene process, will outlast 10 molds which are not hard-faced.

RAILROAD—Eighteen wearing surfaces, hard-faced with Haynes Stellite alloy and only slightly worn after 3 years' service, are visible in this photograph of yokes and spacers for railroad car retarders.

Write for the 104-page book, "Hard-Facing With Haynes Stellite Products," which shows how these products can reduce wear and save money in your industry. There is no obligation.

PRODUCT OF A UNIT OF UCC UNION CARBIDE AND CARBON CORPORATION

"Haynes Stellite" is a registered trade-mark of Haynes Stellite Company.

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Red-hard, wear-resisting alloy of cobalt, chromium and tungsten

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Foreign Sales Department—New York City

Haynes Stellite hard-facing rods and information on other Haynes Stellite Company products also are available through all apparatus shipping points of The Linde Air Products Company

List of New Members

May 1 to May 31, 1939

BOSTON

Powers, James C., Jr. (C), 425 Richmond St., Providence, R. I.

CANADA

Jacobs, David S. (C), Can. Liquid Air Co., 16 Boler St., W. Toronto, Ont., Canada.

CHATTANOOGA

Welch, E. T. (C), 215 Chestnut St., Chattanooga, Tenn.
White, Marvin E. (C), Welding Gas Prods. Co., 821 E. 11th St., Chattanooga, Tenn.

CHICAGO

Dempsey, J. S. (A), The Buda Co., Harvey, Ill.
Maley, Geo. D. (D), 4526 Cedar Ave., Hammond, Ind.

CINCINNATI

Lewis, Alfred J. (D), 49 Fluhart Ave., Dayton, Ohio.

CLEVELAND

Brown, Fred E. (C), 7612 Avondale Ave., Garfield Hgts., Cleveland, Ohio.

COLORADO

Kilgore, Gordon H. (D), 335 Galapago St., Denver, Colo.

COLUMBUS

Broughton, Thomas M. (F), 449 West 5th Ave., Columbus, Ohio.
Emig, E. W. (B), 469 Townsend Ave., Columbus, Ohio.
Gilbert, Yowland (D), 2480 Indianola Ave., Columbus, Ohio.
Isaacson, T. E. (F), 1431 W. 8th St., Ashtabula, Ohio.
Simon, Richard F. (F), 103 E. Woodruff Ave., Columbus, Ohio.

DETROIT

Keyes, J. W. (C), Weldit Acetylene Co., 638 Bagley Ave., Detroit, Mich.

KANSAS CITY

Bain, George (C), Lincoln Electric Co., 1218 Main St., Kansas City, Mo.
Cross, L. H. (D), 112 E. 18th St., Kansas City, Mo.
Gosney, James (B), Industrial Machinery Co., 641 S. W. Blvd., Kansas City, Kansas.
Libby, H. H. (C), Libby Welding Co., 2700 E. 15th St., Kansas City, Mo.
Luthy, S. F. (C), Camp & Luthy, Inc., 1924 Baltimore Ave., Kansas City, Mo.
Peterson, Carl (C), Puritan Compressed Gas Corp., 2012 Grand Ave., Kansas City, Mo.
Williams, Leslie N. (D), 5815 Kingslee Drive, Hickman Mills, Mo.

LOS ANGELES

McClure, E. E. (C), 1440 E. Broadway, Glendale, Calif.

NEW YORK

Boniewski, Edward F. (D), 760 Cortland St., Perth Amboy, N. J.
Burghoorn, L. (D), 412 Woodside Ave., Newark, N. J.
Carr, James H. (D), P. O. Box 44, Arlington, N. J.
Chivvis, George D. (D), 345 Walnut St., Lindenhurst, L. I., N. Y.
Elliott, Joseph (D), 774 St. George Ave., Woodbridge, N. J.
Gorzelnik, Edward M. (D), 393 Lafayette St., Newark, N. J.
Hilse, Fred (D), 852 Bergen St., Newark, N. J.
Mayer, Steve (D), 119 Noble St., Brooklyn, N. Y.

WESTERN NEW YORK

Gaines, John M., Jr. (B), The Linde Air Products Co., Tonawanda, N. Y.

NORTHWEST

Dukes, Marcus R. (B), 526 W. 7th St., St. Paul, Minn.
Ekblad, Axel H. (D), Northern States Power Co., 28th & Marshall St. N. E., Minneapolis, Minn.

OKLAHOMA CITY

Barajas, Paul M. (F), 420 Duck St., Stillwater, Okla.

OMAHA

Larsen, Elmer (C), American Machine Wks., 1210 Jackson St., Omaha, Neb.

PHILADELPHIA

Daley, Wm. J. (D), 3420 N. 18th St., Philadelphia, Pa.

PITTSBURGH

Kelly, W. J. (B), Supt. Marine Ways, Pittsburgh Coal Co., Elizabeth, Pa.

PUGET SOUND

Brett, George S. (C), A. M. Castle & Co., 32 W. Conn. St., Seattle, Washington.
Care, W. R. (C), Seattle Steel Co., 1200—4th Ave. So., Seattle, Washington.
Conrad, Frank A. (B), Puget Sound Sheet Metal Wks., 3631 East Marginal Way, Seattle, Washington.
Drew, L. F. (B), Truck Welding Co., 739—9th Ave., Seattle, Washington.
Flohr, E. F. (C), Bethlehem Steel Co., Box 3147, Seattle, Washington.
Frink, Francis G. (B), Washington Iron Wks., 1500—6th Ave., Seattle, Washington.
Hallum, J. D. (B), Seattle Oxygen Co., 5510 E. Marginal Way, Seattle, Washington.
Haynes, Hanford (B), Commercial Boiler Wks., 53 W. Lander St., Seattle, Washington.
Hoffman, C. H. (B), Seattle Boiler Wks., 5237 East Marginal Way, Seattle, Washington.
Meacham, William A. (B), 417 Smith St., Seattle, Washington.
Morgan, G. S. (B), Service Elec. Welding Co., 305 E. 11th St., Tacoma, Washington.
Nickum, W. C. (B), 400 Polson Bldg., Seattle, Washington.
Russell, Ralph S. (B), Hydraulic Supply Co., 7500—8th Ave. So., Seattle, Washington.
Talmadge, C. W. H. (B), Barde Steel Co., 2709 Utah Ave., Seattle, Washington.
Tepley, George L. (B), Eagle Metals Co., 3628 East Marginal Way, Seattle, Washington.
Thomson, Alexander (B), 8409—55th Ave. So., Seattle, Washington.

QUAD CITIES

Flodeen, Albin H. (B), 2416—28th St., Moline, Ill.
Meyer, Fred G. (B), 2535 East 18th St., Davenport, Iowa.

ST. LOUIS

Bertsch, Dr. John A. (B), Cuproweld, 3512 Halliday Ave., St. Louis, Mo.
Sacks, Raymond J. (D), 1710A N. 14th St., St. Louis, Mo.

SAN FRANCISCO

Berry, Edwin G. (D), 1528 Sonoma Ave., Sacramento, Calif.
Korn, Kenneth E. (D), 2558—18th St., Sacramento, Calif.

SAN JOAQUIN

Beneridge, Edwin F. (C), 1318½ Eye St., Bakersfield, Calif.

SOUTH TEXAS

Hebert, Roy F. (D), T. & N. O. Ry. Co., 324 S. P. Bldg., Houston, Texas.
Jalowy, H. C. (D), T. & N. O. Ry. Co., 324 S. P. Bldg., Houston, Texas.
Luger, K. E. (C), Carnegie-Illinois Steel Co., Box 159, Houston, Texas.
Perkins, Howard (C), Big Three Welding & Equip. Co., Port Arthur, Texas.

TULSA

Morgan, Gus (C), 732 College St., Tulsa, Okla.
Phelps, W. D. (D), c/o A. N. Roberts, Route 8, Afton, Okla.

WICHITA

Brotherton, Earl S. (D), Borbein Young & Co., 220 So. Emporia, Wichita, Kansas.
Reschke, F. Paul (D), Reschke Machine Co., 908 No. Washington St., Wichita, Kansas.

YOUNGSTOWN

Gordon, J. D. (B), The Taylor-Winfield Corp., Warren, Ohio.

NOT IN SECTIONS

Duesing, Ernest (D), R. R. 2, Grand Rapids, Mich.
Neumann, Othon G. (C), P. O. Box 139, Mexico, D. F. Mexico.
Ochsner, Edward (D), R. D. 2, Jamesville, N. Y.

Sections AMERICAN WELDING SOCIETY

CHAIRMEN, SECRETARIES AND REGULAR MEETING DATES

BIRMINGHAM — 3rd Fri.
CHAIRMAN—A. C. LEIGH, Ingalls Iron Works
SECRETARY-TREAS.—W. L. POOLE, Air Reduction Sales Company, 2825 No. 29th Ave., Birmingham

BOSTON — 3rd Mon.
CHAIRMAN—F. B. MEHAFFEY, Air Reduction Sales Co., 122 Mt. Vernon St., Upham Crs., Dorchester, Mass.
SECRETARY—P. N. RUGG, 16 Fairmount Ave., Wakefield, Mass.

CANTON, OHIO (Akron, Alliance, etc.)
ROBERT M. WALLACE, The Griscom-Russell Company, Massillon, Ohio

CHATTANOOGA, TENN. — 1st Wed.
CHAIRMAN—CHESTER RAYMO, Chattanooga Boiler and Tank Company, 1011 East Main Street, Chattanooga
SECRETARY—A. R. MCLAIN, 622 Georgia Avenue, Chattanooga, Tenn.

CHICAGO — 3rd Fri.
CHAIRMAN—E. A. BALSLEY, Link-Belt Co.
SECRETARY—M. S. HENDRICKS, Room 731, 506 South Wabash Avenue

CINCINNATI, OHIO
CHAIRMAN—F. H. SMITH, The Lincoln Electric Company
SECRETARY—ERIC O'HARA, Cincinnati Gas & Electric Company

CLEVELAND — 2nd Wed.
CHAIRMAN—F. L. PLUMMER, Consulting Engr., 914 Standard Bldg.
SECRETARY-TREAS.—A. LESLIE PFEIL, Universal Power Corporation

COLORADO — 3rd Wed.
CHAIRMAN—J. H. JOHNSON, Johnson Supply Co., Denver, Colo.
SECRETARY-TREAS.—H. W. CREAGER, Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

COLUMBUS, OHIO
CHAIRMAN—F. S. CALDWELL, Jeffrey Mfg. Co., Columbus, Ohio
SECRETARY—G. S. HERREN, The Seagrave Corp., Columbus, Ohio

CONNECTICUT — 1st. Tues.
CHAIRMAN—JOHN J. VREELAND, Chase Brass & Copper Co., Waterbury, Conn.
SECRETARY—H. A. PENNINGTON, A. B. King & Co., 196 Chapel Street, New Haven

DETROIT — 1st or 2nd Fri.
CHAIRMAN—D. H. CORBY, The Detroit Edison Company
SECRETARY—E. J. ROUSSEAU, Commerce Pattern & Foundry Co.

GEORGIA — 1st Tues.
CHAIRMAN—GEORGE BIRD, Bird-Potts Company, 376 Marietta St., N. W., Atlanta, Ga.
SECRETARY—ARTHUR MCCOY, Calvert Iron Works, Oakland City, Atlanta, Ga.

HAWAII — 4th. Tues.
CHAIRMAN—E. E. HEACOCK, P. O. Box No. 84, Honolulu, T. H.
SECRETARY—J. K. MARDICK, P. O. Box No. 94, Honolulu, T. H.

INDIANAPOLIS
CHAIRMAN—J. D. TEBBEN, P. R. Mallory Co., 3029 E. Washington St.
SECRETARY—R. D. EAGLESFIELD, JR., 300 So. La Salle St.

KANSAS CITY, MO. — 3rd Mon.
CHAIRMAN—J. L. FIZZELL, National Steel Prods. Co., Kansas City, Mo.
SECRETARY—JIM KIRK, Air Reduction Sales Co., Kansas City, Mo.

LOS ANGELES — 3rd Thurs.
CHAIRMAN—C. P. SANDER, Western Pipe & Steel Co., Los Angeles, Calif.
SECRETARY, J. C. GOWING, 644 E. Florence Ave., Los Angeles, Calif.

LOUISIANA — 1st Fri.
CHAIRMAN—O. B. MCLAUGHLAN, Freeport Sulphur Co., Port Sulphur La.
SECRETARY—CLYDE PINE, The Isaac Delgado Trade School, New Orleans, La.

MARYLAND — 3rd Fri. except April
CHAIRMAN—C. N. HILBINGER, T. A. Canty, Inc.
SECRETARY-TREAS.—R. A. MANSFIELD, Southern Oxygen Co., Baltimore, Md.

MEMPHIS
CHAIRMAN—E. H. GILL, National Butane Co., Memphis, Tenn.
SECRETARY—B. B. DRURY, JR., National Cylinder Gas Co., Memphis, Tenn.

MILWAUKEE — 2nd Wed.
CHAIRMAN—R. W. STERNKE, Lakeside Bridge & Steel Co.
SECRETARY—GILBERT F. MEYER, Machinery & Welder Corp.

MONTANA — 1st Wed.
CHAIRMAN—WM. GALLOWAY, 4407 Blackwater St., Forbes Park.
SECRETARY—H. S. GRIFFITH, Box 1787, Fort Peck, Mont.

NEW YORK — 2nd Tues. except when Joint Meeting is held
CHAIRMAN—CHARLES KANDEL, Craftsweld Equipment Co., Long Island City, N. Y.
SECRETARY—G. V. SLOTTMAN, Air Reduction Sales Co., 60 East 42nd Street

NORTHWEST — 3rd Wed.
CHAIRMAN—T. J. WARMINGTON, Wm. Bros. Boiler & Mfg. Co.
SECRETARY—ALEXIS CASWELL, Manufacturers Assoc. of Minn., 200 Builders Exchange Bldg., Minneapolis

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CHAIRMAN—R. W. CLARK, General Electric Company, Schenectady, N. Y.
SECRETARY—G. A. ROSS, General Electric Co., Schenectady, N. Y.

WESTERN NEW YORK — Last Mon.
CHAIRMAN—J. R. DAWSON, Union Carbide and Carbon Res. Labs., Niagara Falls, N. Y.
SECRETARY—C. S. FREEMAN, The Lincoln Electric Company, Buffalo, N. Y.

OKLAHOMA CITY — 1st Tues.
CHAIRMAN—K. B. BANKS, P. O. Box 1377, Okla. City, Okla.
SECRETARY—C. C. WILLIS, P. O. Box 1498, Oklahoma City.

OMAHA, NEBRASKA — 2nd Thurs.
CHAIRMAN—L. B. THOMAS, Economy Welding Service, 18th & Cuning Sts., Omaha
SECRETARY—G. E. MCGRATH, McGrath Welding Co., 4026 Nicholas, Omaha

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CHAIRMAN—E. E. ISGREN, R. G. Le Tourneau Inc.
SECRETARY—W. J. BROOKING, R. G. LeTourneau, Inc., Peoria, Ill.

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CHAIRMAN—H. R. SALISBURY, Air Reduction Sales Co., Allegheny & 17th Sts., Phila., Pa.
SECRETARY—H. E. HOPKINS, Arcos Corp., 401 N. Broad St.

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CHAIRMAN—LEON C. BIBBER, Carnegie-Illinois Steel Corp., Carnegie Building
SECRETARY—J. F. MINNOTTE, Minnotte Bros., 1201 House Bldg.

PUGET SOUND
CHAIRMAN—H. HAYNES, 53 Lander St., Seattle, Washington
SECRETARY—L. A. BURQUE, Westinghouse Elec. & Mfg. Co., Seattle, Washington

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CHAIRMAN—A. R. GUSTAFSON, 840 Third Ave., Moline, Illinois
SECRETARY—A. T. COX, Lincoln Elec. Co., Moline, Illinois

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CHAIRMAN—EDWIN ALLAN, Allan Iron & Welding Wks., Inc., 133 Murray St.
SECRETARY—PAUL W. JAMES, 17 Lake View Park, Rochester

SAN FRANCISCO — Last Fri.
CHAIRMAN—T. R. ROONEY, Western Pipe & Steel Co.
SECRETARY—J. G. BOLLINGER, Air Reduction Sales, Park & Halleck Sts., Emeryville, Calif.

SAN JOAQUIN VALLEY
CHAIRMAN—G. D. ATMORE, 401 Santa Barbara St., Santa Paula, Calif.
SECRETARY—JAMES BRIDGES, Box 442 Bakersfield, Calif.

ST. LOUIS — 2nd Fri.
CHAIRMAN—N. F. MOSS, 7508 Wayne St. Louis, Mo.
SECRETARY—M. E. MEYERSON, 2317 Chouteau Ave., St. Louis, Mo.

SOUTH TEXAS
CHAIRMAN—L. H. COURTRIGHT, Reed Roller Bit Co., Houston, Texas
SECRETARY—G. V. DYE, G. V. Dye Co., Houston

TULSA, OKLAHOMA
CHAIRMAN—G. L. WILEY, Box 226 W. Tulsa, Okla.
SECRETARY—O. L. ROGERS, Big Three Welding & Equipment Company, Tulsa, Okla.

YOUNGSTOWN (OHIO) — 2nd Mon.
CHAIRMAN—A. O. MILLER, Petroleum Iron Works, Sharon, Penna.
SECRETARY-TREAS.—C. R. RIGGLE, Ohio Edison Co., Youngstown

WASHINGTON, D. C. — 2nd Tues.
CHAIRMAN—C. A. LOOMIS, Bureau of C. & R., Navy Dept.
SECRETARY—G. E. KNOX, Bureau of Yards & Docks, Navy Dept.

WICHITA, KANSAS
CHAIRMAN—L. E. KIRK, Vickers Petroleum Co., Wichita, Kansas
SECRETARY-TREAS.—K. O. HOUSER, Kansas Gas & Electric Co., Wichita, Kansas

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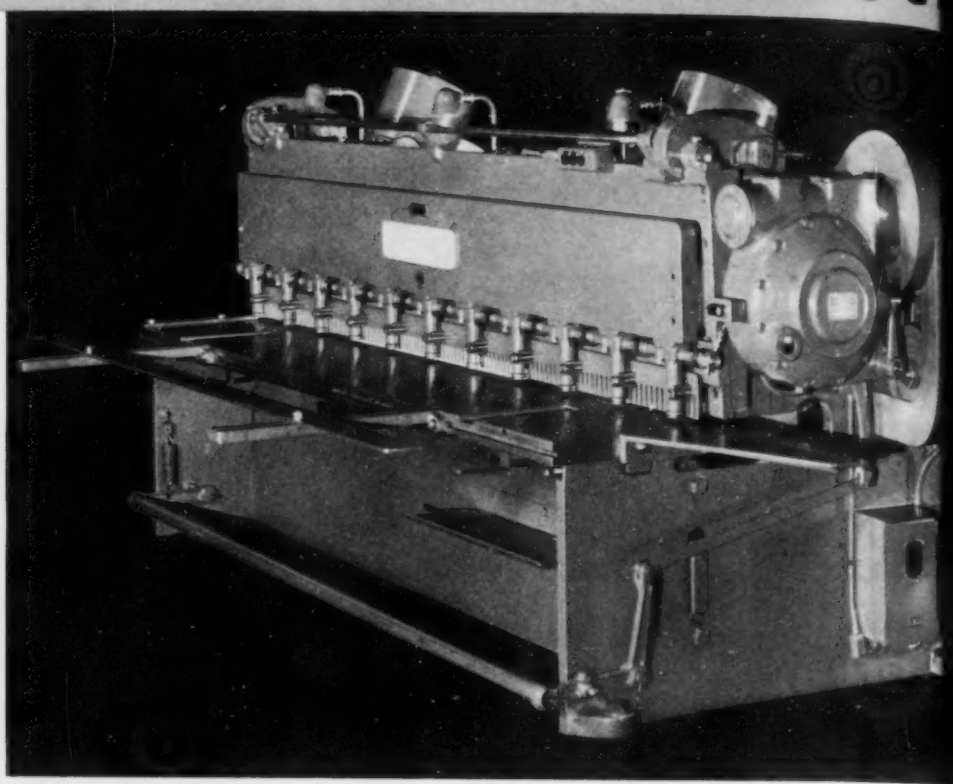

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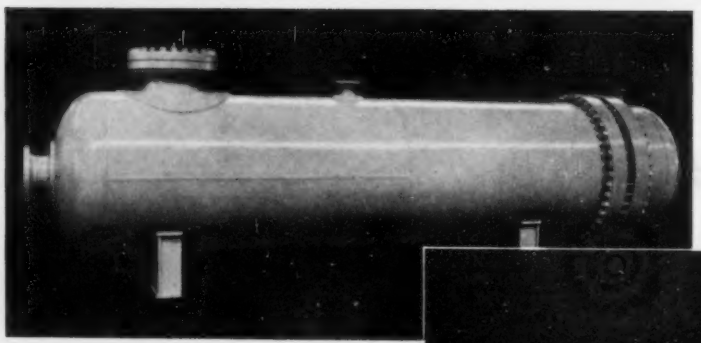
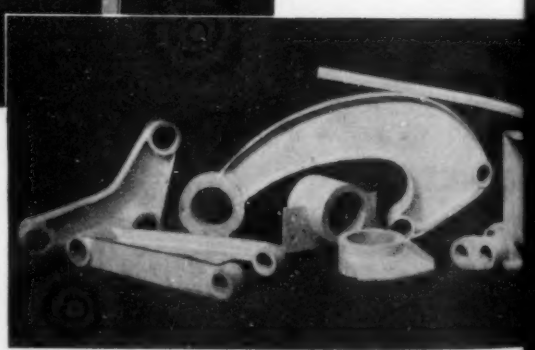
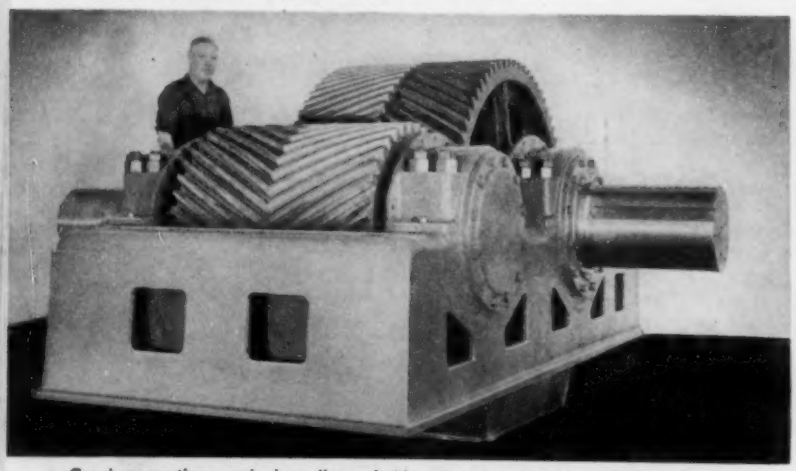


1 This modern, welded st... strong, rigid, precise i... tion—and looks it. Flawles... erly shaped welds play their part... *courtesy Cincinnati Shaper Co... cinnati, Ohio.*

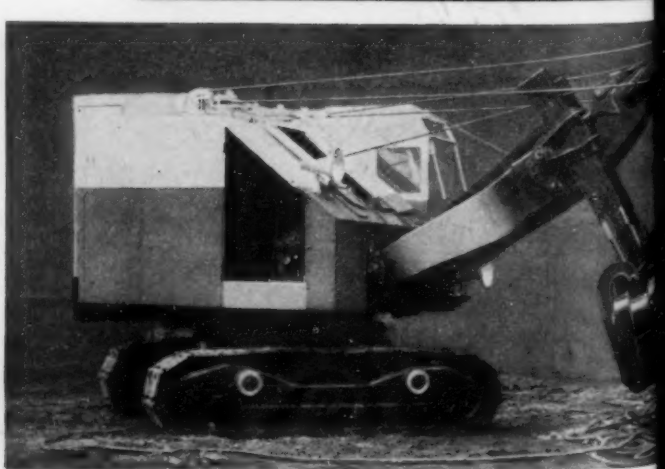


2 Symmetrical, even Murex welded seams in this heat exchanger suggest good workmanship and careful fabrication. *Photo courtesy Struthers-Wells, Warren, Pa.*

3 Welded small parts, replacing castings, must be neat and trim. Smooth, clean Murex deposits keep them so. *Photo courtesy The Dorr Company, Denver, Colo.*



4 Good proportions and clean lines of this mill drive spell tremendous strength. Well-formed Murex welds help carry out the suggestion. *Photo courtesy Farrell-Birmingham Company, Ansonia, Conn.*



5 Ruggedness is apparent in every line of this sturdy tunnel type power shovel... too, look, and are, sound and strong. *Photo courtesy The Marion Steam... Company, Marion, Ohio.*